

**SAMSUNG**



# PRODUCT SELECTION GUIDE

Displays, LEDs, Memory and Storage 2H 2013

DRAM

FLASH-SSD

MCPs

STORAGE

DISPLAYS

CONTACTS

# Samsung Semiconductor, Inc.

Samsung continues to lead the industry with the broadest portfolio of memory products and technology. Its DRAM, flash, mobile, and graphics memory are found in computers — from ultra-mobile notebooks to powerful servers — and in a wide range of handheld devices such as smartphones and tablets. Samsung also delivers the industry's widest line of storage products from the consumer to the enterprise level. These include optical disk drives as well as flash storage, such as Solid State Drives, and a range of embedded and removable flash storage products.

| Markets                       |                                                                                     | DRAM                                                                                | SSD                                                                                 | FLASH                                                                               | ASIC                                                                                  | LOGIC                                                                                 | TFT/LCD                                                                               | ODD                                                                                   |
|-------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Mobile/Wireless               |    |    | N/A                                                                                 |    |    |    |    |    |
| Notebook PCs/<br>Ultrabooks™  |   |   |   |   |   |   |   |   |
| Desktop PCs/<br>Workstations  |  |  |  |  |  |  |  |  |
| Servers                       |  |  |  |  |  |  |  |  |
| Networking/<br>Communications |  |  |  |  |  |  | N/A                                                                                   |  |
| Consumer<br>Electronics       |  |  | N/A                                                                                 |  |  |  |  |  |

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ENTERPRISE  
E-MODE DESIGN  
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DYNAMIC  
LOGIC INNOVATION  
MEMORY  
GREEN  
CUTTING  
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NAND



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- DDR2 SDRAM
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- DRAM Ordering Information

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## DDR4 SDRAM REGISTERED MODULES

| Density                                                                                                      | Voltage | Organization | Part Number      | Composition      | Compliance                          | Speed (Mbps) | Ranks | Production |
|--------------------------------------------------------------------------------------------------------------|---------|--------------|------------------|------------------|-------------------------------------|--------------|-------|------------|
| 8GB                                                                                                          | 1.2V    | 1Gx 72       | M393A1G40DB0-CPB | 4Gb (1G x4) * 18 | Lead Free & Halogen Free, Flip Chip | 2133         | 1     | 3Q'13      |
| 16GB                                                                                                         | 1.2V    | 2Gx72        | M393A2G40DB0-CPB | 4Gb (1G x4) * 36 | Lead Free & Halogen Free, Flip Chip | 2133         | 2     | 3Q'13      |
| Notes: Register is not fixed yet NA = DDR4-1866 (14-14-14) QB = DDR4-2133(16-16-16) PB = DDR4-2133(15-15-15) |         |              |                  |                  |                                     |              |       |            |

## DDR4 SDRAM LOAD REDUCED MODULES

| Density                                                                                                      | Voltage | Organization | Part Number    | Composition         | Compliance               | Speed (Mbps) | Ranks | Production |
|--------------------------------------------------------------------------------------------------------------|---------|--------------|----------------|---------------------|--------------------------|--------------|-------|------------|
| 32GB                                                                                                         | 1.2V    | 4Gx 72       | M386A4GDM0-CPB | 4Gb MDP (2Gx4) * 36 | Lead Free & Halogen Free | 2133         | 4     | 4Q'13      |
| Notes: Register is not fixed yet NA = DDR4-1866 (14-14-14) QB = DDR4-2133(16-16-16) PB = DDR4-2133(15-15-15) |         |              |                |                     |                          |              |       |            |

## DDR3 SDRAM REGISTERED MODULES

| Density | Voltage | Organization | Part Number                        | Composition          | Compliance                          | Speed (Mbps)        | Ranks | Production |
|---------|---------|--------------|------------------------------------|----------------------|-------------------------------------|---------------------|-------|------------|
| 1GB     | 1.5V    | 128Mx72      | M393B2873GB0-C(F8/H9/K0/MA)(08/09) | 1Gb (128M x8) * 9    | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 1     | Now        |
| 2GB     | 1.5V    | 256Mx72      | M393B5673GB0-C(F8/H9/K0/MA)(08/09) | 1Gb (128M x8) * 18   | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M393B5670GB0-C(F8/H9/K0/MA)(08/09) | 1Gb (256M x4) * 18   | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 1     | Now        |
|         |         |              | M393B5773DH0-C(F8/H9/K0/MA)(08/09) | 2Gb (256M x8) * 9    | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 1     | Now        |
|         |         |              | M393B5170GB0-C(F8/H9/K0/MA)(08/09) | 1Gb (256M x4) * 36   | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 2     | Now        |
| 4GB     | 1.5V    | 512Mx72      | M393B5273DH0-C(F8/H9/K0/MA)(08/09) | 2Gb (256M x8) * 18   | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M393B5270DH0-C(F8/H9/K0/MA)(08/09) | 2Gb (512M x4) * 18   | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 1     | Now        |
|         |         |              | M393B1K73DH0-C(F8/H9)(08/09)       | 2Gb (256M x8) * 36   | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |
| 8GB     | 1.5V    | 1Gx72        | M393B1K70DH0-C(F8/H9/K0/MA)(08/09) | 2Gb (512M x4) * 36   | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M393B1K70QB0-C(K0/MA) (08/09)      | 2Gb (512M x4) * 36   | Lead Free & Halogen Free            | 1600/1866           | 2     | Q3'13      |
|         |         |              | M393B1G70BH0-C(F8/H9/K0/MA)(08/09) | 4Gb (1G x4) * 18     | Lead Free & Halogen Free            | 1066/1333           | 1     | Now        |
|         |         |              | M393B1G70QH0-C(K0/MA) (08/09)      | 4Gb (1G x4) * 18     | Lead Free & Halogen Free            | 1600/1866           | 1     | Q3'13      |
|         |         |              | M393B1G73BH0-C(F8/H9/K0/MA)(08/09) | 4Gb (512M x8) * 18   | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M393B1G70QB0-C(K0/MA) (08/09)      | 4Gb (1G x4) * 36     | Lead Free & Halogen Free            | 1600/1866           | 2     | Now        |
|         |         |              | M393B2K70DM0-C(F8/H9)(08/09)       | 2Gb DDP (1G x4) * 36 | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |
|         |         |              | M393B2G70BH0-C(K0/MA)(08/09)       | 4Gb (1G x4) * 36     | Lead Free & Halogen Free            | 1600/1866           | 2     | Now        |
| 16GB    | 1.5V    | 2Gx72        | M393B2G70QB0-C(K0/MA)(08/09)       | 4Gb (1G x4) * 36     | Lead Free & Halogen Free            | 1600/1866           | 2     | Now        |
|         |         |              | M393B2G70DB0-C(K0/MA)(02/03)       | 4Gb (1G x4) * 36     | Lead Free & Halogen Free            | 1600/1866           | 2     | Now        |
| 32GB    | 1.5V    | 4Gx72        | M393B4G70BM0-C(F8/H9)(08/09)       | 8Gb DDP (2G x4) * 36 | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |
| 2GB     | 1.35V   | 256Mx72      | M393B5773DH0-Y(F8/H9/K0)(08/09)    | 2Gb (256M x4) * 9    | Lead Free & Halogen Free            | 1066/1333/1600      | 1     | Now        |
| 4GB     | 1.35V   | 512Mx72      | M393B5173GB0-Y(F8/H9)(08/09)       | 1Gb (128M x8) * 36   | Lead Free & Halogen Free, Flip Chip | 1066/1333           | 4     | Now        |
|         |         |              | M393B5170GB0-Y(F8/H9/K0)(08/09)    | 1Gb (256M x4) * 36   | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600      | 2     | Now        |
|         |         |              | M393B5273DH0-Y(F8/H9/K0)(08/09)    | 2Gb (256M x8) * 18   | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
|         |         |              | M393B5270DH0-Y(F8/H9/K0)(08/09)    | 2Gb (512M x4) * 18   | Lead Free & Halogen Free            | 1066/1333/1600      | 1     | Now        |
| 8GB     | 1.35V   | 1Gx72        | M393B1G70BH0-Y(F8/H9/K0)(08/09)    | 4Gb (1G x4) * 18     | Lead Free & Halogen Free            | 1066/1333/1600      | 1     | Now        |
|         |         |              | M393B1K70QB0-Y(H9/K0) (08/09)      | 2Gb (512M x4) * 36   | Lead Free & Halogen Free            | 1333/1600           | 2     | Q3'13      |
|         |         |              | M393B1G70QH0-Y(H9/K0) (08/09)      | 4Gb (1G x4) * 18     | Lead Free & Halogen Free            | 1333/1600           | 2     | Now        |
|         |         |              | M393B1G73BH0-Y(F8/H9/K0)(08/09)    | 4Gb (512M x8) * 18   | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
| 16GB    | 1.35V   | 2Gx72        | M393B2G70BH0-Y(F8/H9/K0)(08/09)    | 4Gb (1G x4) * 36     | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
|         |         |              | M393B2G70BH0-Y(H9/K0) (08/09)      | 4Gb (1G x4) * 36     | Lead Free & Halogen Free            | 1600/1866           | 2     | Now        |
|         |         |              | M393B2G70QB0-Y(H9/K0) (08/09)      | 4Gb (1G x4) * 36     | Lead Free & Halogen Free            | 1600/1866           | 2     | Now        |
|         |         |              | M393B2G70DB0-Y(H9/K0) (02/03)      | 4Gb (1G x4) * 36     | Lead Free & Halogen Free            | 1600/1866           | 2     | Now        |
|         |         |              | M393B2G70QH0-Y(K0) (08/09)         | 4Gb (1G x4) * 36     | Lead Free & Halogen Free            | 1600/ 1866*         | 2     | Q3'13      |
|         |         |              | M393B2G73BH0-Y(F8/H9)(08/09)       | 4Gb (512M x8) * 36   | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |
|         |         |              | M393B2G73BH0-C(F8/H9)(08/09)       | 4Gb (512M x8) * 36   | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |
|         |         |              | M393B2K70DM0-Y(F8/H9)(08/09)       | 4Gb DDP (1G x4) * 36 | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |
| 32GB    | 1.35V   | 4Gx72        | M393B4G70BM0-Y(F8/H9)(08/09)       | 8Gb DDP (2G x4) * 36 | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |
|         |         |              | M393B4G70DM0-YH9(02/03)            | 8Gb DDP (2G x4) * 36 | Lead Free & Halogen Free            | 1333                | 4     | Q3'13      |

Notes: 04 = IDT B0 register  
05 = Inphi C0 register  
08 = IDT A1  
09 = Inphi UV GS02  
\* K0 (1600Mbps) available in ES only

F8 = DDR3-1066 (7-7-7)  
H9 = DDR3-1333 (9-9-9)  
K0 = DDR3-1600 (11-11-11)  
MA = DDR3-1866 (13-13-13)

## DDR3 SDRAM LOAD REDUCED REGISTERED MODULES

| Density | Voltage    | Organization | Part Number                    | Composition           | Compliance               | Speed (Mbps)   | Ranks | Production |
|---------|------------|--------------|--------------------------------|-----------------------|--------------------------|----------------|-------|------------|
| 16GB    | 1.35V      | 2Gx72        | M386B2K70DM0-YH90              | 4Gb DDP (1G x4) * 36  | Lead Free & Halogen Free | 1333           | 4     | Now        |
| 32GB    | 1.35V/1.5V | 4Gx72        | M386B4G70BM0-YK0(3/4)/CMA(3/4) | 8Gb DDP (2G x4) * 36  | Lead Free & Halogen Free | 1333/1600/1866 | 4     | Now        |
|         |            |              | M386B4G70DM0-YK0(3/4)/CMA(3/4) | 8Gb DDP (2G x4) * 36  | Lead Free & Halogen Free | 1600/1866      | 4     | Q3'13      |
| 64GB    | 1.35V/1.5V | 8Gx72        | M386B8G70B00-YH94/CK04         | 4Gb QDP (4G x4) * 36  | Lead Free & Halogen Free | 1333/1600      | 8     | Now        |
|         |            |              | M386B8G70DE0-YH9(4)/CK0(4)     | 16Gb QDP (4G x4) * 36 | Lead Free & Halogen Free | 1333/1600      | 8     | Q3'13      |

Notes: 0 = Inphi iMB GS02A  
3 = Inphi iMB GS02B  
4 = Montage C1

## DDR3 SDRAM VLP REGISTERED MODULES

| Density | Voltage | Organization | Part Number                        | Composition            | Compliance                          | Speed (Mbps)        | Ranks | Production |
|---------|---------|--------------|------------------------------------|------------------------|-------------------------------------|---------------------|-------|------------|
| 1GB     | 1.5V    | 128Mx72      | M392B2873GB0-C(F8/H9/K0/MA)(08/09) | 1Gb (128M x8) * 9      | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 1     | Now        |
| 2GB     | 1.5V    | 256Mx72      | M392B5673GB0-C(F8/H9/K0/MA)(08/09) | 1Gb (128M x8) * 18     | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M392B5670GB0-C(F8/H9/K0/MA)(08/09) | 1Gb (256M x8) * 18     | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 1     | Now        |
|         |         |              | M392B5773DH0-C(F8/H9/K0/MA)(08/09) | 2Gb (256M x8) * 9      | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 1     | Now        |
| 4GB     | 1.5V    | 512Mx72      | M392B5273DH0-C(F8/H9/K0/MA)(08/09) | 2Gb (256M x8) * 18     | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M392B5270DH0-C(F8/H9/K0/MA)(08/09) | 2Gb (512M x4) * 18     | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 1     | Now        |
| 8GB     | 1.5V    | 1Gx72        | M392B1K73DM0-C(F8/H9)(08/09)       | 2Gb DDP (512M x8) * 18 | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |
|         |         |              | M392B1K70DM0-C(F8/H9/K0/MA)(08/09) | 2Gb DDP (1G x4) * 18   | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M392B1G73BH0-C(F8/H9/K0/MA)(08/09) | 4Gb (512M x8) * 18     | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 1     | Now        |
|         |         |              | M392B1G73DB0-CMA (08/09)           | 4Gb (512M x8) * 18     | Lead Free & Halogen Free            | 1866                | 1     | Q3'13      |
|         |         |              | M392B1G70BH0-C(F8/H9/K0/MA)(08/09) | 4Gb (1G x4) * 18       | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 1     | Now        |
| 16GB    | 1.5V    | 2Gx72        | M392B2G70BM0-C(F8/H9/K0/MA)(08/09) | 8Gb DDP (2G x4) * 18   | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M392B2G70DM0-YK0/CMA (03/04)       | 8Gb DDP (2G x4) * 18   | Lead Free & Halogen Free            | 1600/1866           | 2     | Q3'13      |
|         |         |              | M392B2G73BM0-C(F8/H9)(08/09)       | 4Gb DDP (1G x8) * 18   | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |
| 2GB     | 1.35V   | 256Mx72      | M392B5773DH0-Y(F8/H9/K0)(08/09)    | 2Gb (256M x8) * 9      | Lead Free & Halogen Free            | 1066/1333/1600      | 1     | Now        |
| 4GB     | 1.35V   | 512Mx72      | M392B5273DH0-Y(F8/H9/K0)(08/09)    | 2Gb (256M x8) * 18     | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
|         |         |              | M392B5270DH0-Y(F8/H9/K0)(08/09)    | 2Gb (512M x4) * 18     | Lead Free & Halogen Free            | 1066/1333/1600      | 1     | Now        |
| 8GB     | 1.35V   | 1Gx72        | M392B1K73DM0-Y(F8/H9)(08/09)       | 4Gb DDP (512M x8) * 18 | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |
|         |         |              | M392B1K70DM0-Y(F8/H9/K0)(08/09)    | 2Gb DDP (1G x4) * 18   | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
|         |         |              | M392B1G73BH0-Y(F8/H9/K0)(08/09)    | 4Gb (512M x8) * 18     | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
|         |         |              | M392B1G73DB0-YK0/CMA (03/04)       | 4Gb (512M x8) * 18     | Lead Free & Halogen Free            | 1600/1866           | 2     | Now        |
|         |         |              | M392B1G70BH0-Y(F8/H9/K0)(08/09)    | 4Gb (1G x4) * 18       | Lead Free & Halogen Free            | 1066/1333/1600      | 1     | Now        |
| 16GB    | 1.35V   | 2Gx72        | M392B2G70BM0-Y(F8/H9/K0)(08/09)    | 8Gb DDP (2G x4) * 18   | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
|         |         |              | M392B2G70DM0-YK0 (03/04)           | 8Gb DDP (1G x8) * 18   | Lead Free & Halogen Free            | 1600                | 4     | Now        |
| 32GB    | 1.35V   | 4Gx72        | M392B4G70BE0-Y(F8/H9)(08)          | 4Gb QDP (4G x4) * 18   | Lead Free & Halogen Free            | 1066/1333           | 4     | Now        |

Notes: 04 = IDT B0 register  
05 = Inphi C0 register  
08 = IDT A1  
09 = Inphi UV GS02  
F8 = DDR3-1066 (7-7-7)  
H9 = DDR3-1333 (9-9-9)  
K0 = DDR3-1600 (11-11-11)  
MA = DDR3-1866 (13-13-13)



## DDR3 SDRAM UNBUFFERED MODULES

| Density | Voltage | Organization | Part Number                 | Composition        | Compliance                          | Speed (Mbps)        | Ranks | Production |
|---------|---------|--------------|-----------------------------|--------------------|-------------------------------------|---------------------|-------|------------|
| 1GB     | 1.5V    | 128Mx64      | M378B2873GB0-C(F8/H9/K0/MA) | 1Gb (128M x8) * 8  | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 1     | Now        |
| 2GB     | 1.5V    | 256Mx64      | M378B5673GB0-C(F8/H9/K0/MA) | 1Gb (128M x8) * 16 | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M378B5773DH0-C(F8/H9/K0/MA) | 2Gb (256M x8) * 8  | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 1     | Now        |
|         |         |              | M378B5773QB0-CK0/MA         | 2Gb (256M x8) * 8  | Lead Free & Halogen Free            | 1600/1866           | 1     | Q4'13      |
| 4GB     | 1.5V    | 512Mx64      | M378B5273CH0-C(F8/H9)       | 2Gb (256M x8) * 16 | Lead Free & Halogen Free            | 1066/1333           | 2     | Now        |
|         |         |              | M378B5273DH0-C(F8/H9/K0/MA) | 2Gb (256M x8) * 16 | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M378B5173QH0-C(K0/MA)       | 4Gb (512M x8) * 8  | Lead Free & Halogen Free            | 1600/1866           | 1     | Q3'13      |
|         |         |              | M378B5173DB0-C(K0/MA)       | 4Gb (512M x8) * 8  | Lead Free & Halogen Free            | 1600/1866           | 1     | Now        |
| 8GB     | 1.5V    | 1024Mx64     | M378B1G73BH0-C(F8/H9/K0/MA) | 4Gb (512M x8) * 16 | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M378B1G73QH0-C(K0/MA)       | 4Gb (512M x8) * 16 | Lead Free & Halogen Free            | 1600/1866           | 2     | Q3'13      |
|         |         |              | M378B1G73DB0-C(K0/MA)       | 4Gb (512M x8) * 16 | Lead Free & Halogen Free            | 1600/1866           | 2     | Now        |

## DDR3 SDRAM UNBUFFERED MODULES (with ECC)

| Density | Voltage | Organization | Part Number                 | Composition        | Compliance                          | Speed (Mbps)        | Ranks | Production |
|---------|---------|--------------|-----------------------------|--------------------|-------------------------------------|---------------------|-------|------------|
| 1GB     | 1.5V    | 128Mx72      | M391B2873GB0-C(F8/H9/K0/MA) | 1Gb (128M x8) * 9  | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 1     | Now        |
| 2GB     | 1.5V    | 256Mx72      | M391B5673GB0-C(F8/H9/K0/MA) | 1Gb (128M x8) * 18 | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M391B5773CH0-C(F8/H9)       | 2Gb (256M x8) * 9  | Lead Free & Halogen Free            | 1066/1333           | 1     | Now        |
|         |         |              | M391B5773DH0-C(F8/H9/K0/MA) | 2Gb (256M x8) * 9  | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 1     | Now        |
| 4GB     | 1.5V    | 512Mx72      | M391B5273CH0-C(F8/H9)       | 2Gb (256M x8) * 18 | Lead Free & Halogen Free            | 1066/1333           | 2     | Now        |
|         |         |              | M391B5273DH0-C(F8/H9/K0/MA) | 2Gb (256M x8) * 18 | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
| 8GB     | 1.5V    | 1024Mx72     | M391B1G73BH0-C(F8/H9/K0/MA) | 4Gb (512M x8) * 18 | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M391B1G73QH0-C(MA)          | 4Gb (512M x8) * 18 | Lead Free & Halogen Free            | 1866                | 2     | Q3'13      |
| 1GB     | 1.35V   | 128Mx72      | M391B2873GB0-Y(F8/H9/K0)    | 1Gb (128M x8) * 9  | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600      | 1     | Now        |
| 2GB     | 1.35V   | 256Mx72      | M391B5673GB0-Y(F8/H9/K0)    | 1Gb (128M x8) * 18 | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600      | 2     | Now        |
|         |         |              | M391B5773CH0-Y(F8/H9)       | 2Gb (256M x8) * 9  | Lead Free & Halogen Free            | 1066/1333           | 1     | Now        |
|         |         |              | M391B5773DH0-Y(F8/H9/K0)    | 2Gb (256M x8) * 9  | Lead Free & Halogen Free            | 1066/1333/1600      | 1     | Now        |
| 4GB     | 1.35V   | 512Mx72      | M391B5273CH0-Y(F8/H9)       | 2Gb (256M x8) * 18 | Lead Free & Halogen Free            | 1066/1333           | 2     | Now        |
|         |         |              | M391B5273DH0-Y(F8/H9/K0)    | 2Gb (256M x8) * 18 | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
|         |         |              | M391B5173QH0-YK0            | 4Gb (512M x8) * 9  | Lead Free & Halogen Free            | 1600                | 1     | Q3'13      |
| 8GB     | 1.35V   | 1024Mx72     | M391B1G73BH0-Y(F8/H9/K0)    | 4Gb (512M x8) * 18 | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
|         |         |              | M391B1G73QH0-YK0            | 4Gb (512M x8) * 18 | Lead Free & Halogen Free            | 1600                | 2     | Q3'13      |

Notes: F8 = DDR3-1066 (7-7-7)      K0 = DDR3-1600 (11-11-11)  
H9 = DDR3-1333 (9-9-9)      MA = DDR3-1866 (13-13-13)

## DDR3 SDRAM SODIMM MODULES

| Density | Voltage | Organization | Part Number                 | Composition        | Compliance                          | Speed (Mbps)        | Ranks | Production |
|---------|---------|--------------|-----------------------------|--------------------|-------------------------------------|---------------------|-------|------------|
| 1GB     | 1.5V    | 128Mx64      | M471B2873GB0-C(F8/H9/K0/MA) | 1Gb (128M x8) * 8  | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 1     | Now        |
| 2GB     | 1.5V    | 256Mx64      | M471B5673GB0-C(F8/H9/K0/MA) | 1Gb (128M x8) * 16 | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 2     | Now        |
| 4GB     | 1.5V    | 512Mx64      | M471B5773DH0-C(F8/H9/K0/MA) | 2Gb (256M x8) * 8  | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 1     | Now        |
|         |         |              | M471B5273DH0-C(F8/H9/K0/MA) | 2Gb (256M x8) * 16 | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
|         |         |              | M471B5173BH0-C(F8/H9/K0/MA) | 4Gb (512M x8) * 8  | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 1     | Now        |
| 8GB     | 1.5V    | 1024Mx64     | M471B1G73BH0-C(F8/H9/K0/MA) | 4Gb (512M x8) * 16 | Lead Free & Halogen Free            | 1066/1333/1600/1866 | 2     | Now        |
| 1GB     | 1.35V   | 128Mx64      | M471B2873GB0-Y(F8/H9/K0)    | 1Gb (128M x8) * 8  | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866 | 1     | Now        |
| 2GB     | 1.35V   | 256Mx64      | M471B5673GB0-Y(F8/H9/K0)    | 1Gb (128M x8) * 16 | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600      | 2     | Now        |
|         |         |              | M471B5773DH0-Y(F8/H9/K0)    | 2Gb (256M x8) * 8  | Lead Free & Halogen Free            | 1066/1333/1600      | 1     | Now        |
|         |         |              | M471B5674QH0-YK0            | 4Gb (256M x16) * 4 | Lead Free & Halogen Free            | 1600                | 1     | Q4'13      |
| 4GB     | 1.35V   | 512Mx64      | M471B5273DH0-Y(F8/H9/K0)    | 2Gb (256M x8) * 16 | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
|         |         |              | M471B5173BH0-Y(F8/H9/K0)    | 4Gb (512M x8) * 8  | Lead Free & Halogen Free            | 1066/1333/1600      | 1     | Now        |
|         |         |              | M471B5173QH0-YK0            | 4Gb (512M x8) * 8  | Lead Free & Halogen Free            | 1600                | 1     | Q3'13      |
|         |         |              | M471B5173DB0-YK0            | 4Gb (512M x8) * 8  | Lead Free & Halogen Free            | 1600                | 1     | Q3'13      |
| 8GB     | 1.35V   | 1024Mx64     | M471B1G73BH0-Y(F8/H9/K0)    | 4Gb (512M x8) * 16 | Lead Free & Halogen Free            | 1066/1333/1600      | 2     | Now        |
|         |         |              | M471B1G73QH0-YK0            | 4Gb (512M x8) * 16 | Lead Free & Halogen Free            | 1600                | 2     | Q3'13      |
|         |         |              | M471B1G73DB0-YK0            | 4Gb (512M x8) * 16 | Lead Free & Halogen Free            | 1600                | 2     | Q3'13      |

Notes: F8 = DDR3-1066 (7-7-7) K0 = DDR3-1600 (11-11-11)  
H9 = DDR3-1333 (9-9-9) MA = DDR3-1866 (13-13-13)

## DDR3 SDRAM ECC SODIMM MODULES

| Density | Organization | Part Number | Composition         | Compliance | Speed (Mbps)             | Register  | Rank | Production |
|---------|--------------|-------------|---------------------|------------|--------------------------|-----------|------|------------|
| 2GB     | 1.35V        | 256Mx64     | M474B5773DH0-YH9/K0 | 2Gb x8*9   | Lead Free & Halogen Free | 1333/1600 | 1    | Now        |
| 4GB     | 1.35V        | 512Mx64     | M474B5273DH0-YH9/K0 | 2Gb x8*18  | Lead Free & Halogen Free | 1333/1600 | 2    | Now        |
|         |              |             | M474B5173BH0-YH9/K0 | 4Gb x8*9   | Lead Free & Halogen Free | 1333/1600 | 1    | Now        |
| 8GB     | 1.35V        | 1024Mx64    | M474B1G73BH0-YH9/K0 | 4Gb x8*18  | Lead Free & Halogen Free | 1333/1600 | 2    | Now        |
|         |              |             | M474B1G73QH0-YK0    | 4Gb x8*18  | Lead Free & Halogen Free | 1600      | 2    | Q3'13      |
|         |              |             | M474B1G73QH0-CMA    | 4Gb x8*18  | Lead Free & Halogen Free | 1866      | 2    | Q3'13      |

Notes: E6 = PC2-5300 (DDR2-667 @ CL=5)  
F7 = PC2-6400 (DDR2-800 @ CL=6)  
E7 = PC2-6400 (DDR2-800 @ CL=5)

## DDR3 SDRAM COMPONENTS

| Density | Voltage | Organization | Part Number                   | # Pins-Package | Compliance                          | Speed (Mbps)             | Dimensions | Production |
|---------|---------|--------------|-------------------------------|----------------|-------------------------------------|--------------------------|------------|------------|
| 1Gb     | 1.5V    | 256M x4      | K4B1G0446G-BC(F8/H9/K0/MA)    | 78 Ball -FBGA  | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866      | 7.5x11mm   | Now        |
|         |         | 128M x8      | K4B1G0846G-BC(F8/H9/K0/MA)    | 78 Ball -FBGA  | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866      | 7.5x11mm   | Now        |
|         |         | 128M x16     | K4B1G1646G-BC(F8/H9/K0/MA/NB) | 96 Ball -FBGA  | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600/1866/2133 | 7.5x13.3mm | Now        |
| 2Gb     | 1.5V    | 512M x4      | K4B2G0446C-HC(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600           | 7.5x11mm   | Now        |
|         |         |              | K4B2G0446D-HC(F8/H9/K0/MA)    | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600/1866      | 7.5x11mm   | Now        |
|         |         |              | K4B2G0446Q-BC(K0/MA)          | 78 Ball -FBGA  | Lead Free & Halogen Free, Flip Chip | 1600/1866                | 7.5x11mm   | Now        |
|         |         | 256M x8      | K4B2G0846C-HC(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600           | 7.5x11mm   | Now        |
|         |         |              | K4B2G0846D-HC(F8/H9/K0/MA)    | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600/1866      | 7.5x11mm   | Now        |
|         |         |              | K4B2G0846Q-BC(K0/MA)          | 78 Ball -FBGA  | Lead Free & Halogen Free, Flip Chip | 1600/1866                | 7.5x11mm   | Now        |
|         |         | 128M x16     | K4B2G1646C-HC(F8/H9/K0/MA)    | 96 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600/1866      | 7.5x13.3mm | Now        |
|         |         |              | K4B2G1646E-BC(F8/H9/K0/MA)    | 96 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600/1866      | 7.5x13.3mm | Now        |
|         |         |              | K4B2G1646Q-B(K0/MA/NB)        | 96 Ball -FBGA  | Lead Free & Halogen Free            | 1600/1866/2133           | 7.5x13.3mm | Q3'13      |
| 4Gb     | 1.5V    | 1G x4        | K4B4G0446B-HC(F8/H9/K0/MA)    | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600/1866      | 10x11mm    | Now        |
|         |         |              | K4B4G0446Q-HC(K0/MA)          | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1600/1866                | 10x11mm    | Now        |
|         |         | 512M x8      | K4B4G0846B-HC(F8/H9/K0/MA)    | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600/1866      | 10x11mm    | Now        |
|         |         |              | K4B4G0846D-HC(K0/MA)          | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1600/1866                | 7.5x11mm   | Now        |
|         |         |              | K4B4G0846Q-HC(K0/MA)          | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1600/1866                | 10x11mm    | Now        |
|         |         | 256Mx16      | K4B4G1646B-HC(F8/H9/K0/MA)    | 96 Ball -FBGA  | Lead Free & Halogen Free            | 1333/1600/1866/2133      | 10x13.3mm  | Now        |
|         |         |              | K4B4G1646D-BC(K0/MA)          | 96 Ball -FBGA  | Lead Free & Halogen Free            | 1600/1866                | 7.5x13.3mm | Q3'13      |
| 1Gb     | 1.35V   | 256M x4      | K4B1G0446F-HY(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600           | 7.5x11mm   | Now        |
|         |         |              | K4B1G0446G-BY(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600           | 7.5x11mm   | Now        |
|         | 1.35V   | 128M x8      | K4B1G0846F-HY(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600           | 7.5x11mm   | Now        |
|         |         |              | K4B1G0846G-BY(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free, Flip Chip | 1066/1333/1600           | 7.5x11mm   | Now        |
| 2Gb     | 1.35V   | 512M x4      | K4B2G0446C-HY(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600           | 7.5x11mm   | Now        |
|         |         |              | K4B2G0446D-HY(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600           | 7.5x11mm   | Now        |
|         |         |              | K4B2G0446Q-BY(K0)             | 78 Ball -FBGA  | Lead Free & Halogen Free, Flip Chip | 1600                     | 7.5x11mm   | Now        |
|         |         | 256M x8      | K4B2G0846C-HY(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600           | 7.5x11mm   | Now        |
|         |         |              | K4B2G0846D-HY(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600           | 7.5x11mm   | Now        |
|         |         |              | K4B2G0846Q-BY(K0)             | 78 Ball -FBGA  | Lead Free & Halogen Free, Flip Chip | 1600                     | 7.5x11mm   | Now        |
| 4Gb     | 1.35V   | 1G x4        | K4B4G0446B-HY(F8/H9/K0)       | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600           | 10x11mm    | Now        |
|         |         |              | K4B4G0446D-HY(K0)             | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1600                     | 7.5x11mm   | Now        |
|         |         |              | K4B4G0446Q-HY(K0)             | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1600                     | 10x11mm    | Now        |
|         |         | 512M x8      | K4B4G0846B-HY(F8/H9/K0/MA)    | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1066/1333/1600/1866      | 10x11mm    | Now        |
|         |         |              | K4B4G0846D-BC(K0/MA)          | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1600/1866                | 10x11mm    | Q3'13      |
|         |         |              | K4B4G0846D-HY(K0)             | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1600                     | 7.5x11mm   | Now        |
|         |         |              | K4B4G0846Q-HY(K0)             | 78 Ball -FBGA  | Lead Free & Halogen Free            | 1600                     | 10x11mm    | Now        |
|         |         | 256Mx16      | K4B4G1646B-HY(K0/MA)          | 96 Ball -FBGA  | Lead Free & Halogen Free            | 1333/1600/1866/2133      | 10x13.3mm  | Now        |
|         |         |              | K4B4G1646D-BY(K0/MA)          | 96 Ball -FBGA  | Lead Free & Halogen Free            | 1600/1866                | 7.5x13.3mm | Q3'13      |

Notes: F8 = DDR3-1066 (7-7-7) K0 = DDR3-1600 (11-11-11)  
H9 = DDR3-1333 (9-9-9) MA = DDR3-1866 (13-13-13)

NB = DDR3-2133 (14-14-14)

## DDR2 SDRAM COMPONENTS

| Density | Organization | Part Number                | # Pins-Package | Dimensions | Package                  | Speed (Mbps) | Production |
|---------|--------------|----------------------------|----------------|------------|--------------------------|--------------|------------|
| 256Mb   | 16Mx16       | K4T56163QN-HC(E6/F7/E7/F8) | 84-FBGA        | 7.5x12.5mm | Lead free & Halogen free | 667/800/1066 | Now        |
| 512Mb   | 128M x4      | K4T51043QJ-HC(E6/F7/E7)    | 60-FBGA        | 7.5x9.5mm  | Lead free & Halogen free | 667/800      | Now        |
|         | 64M x8       | K4T51083QJ-HC(E6/F7/E7/F8) | 60-FBGA        | 7.5x9.5mm  | Lead free & Halogen free | 667/800/1066 | Now        |
|         | 32M x16      | K4T51163QJ-HC(E6/F7/E7/F8) | 84-FBGA        | 7.5x12.5mm | Lead free & Halogen free | 667/800/1066 | Now        |
|         | 256M x4      | K4T1G044QF-BC(E6/F7/E7)    | 60-FBGA        | 7.5x9.5mm  | Lead free & Halogen free | 667/800      | Now        |
| 1Gb     | 128M x8      | K4T1G084QF-BC(E6/F7/E7/F8) | 60-FBGA        | 7.5x9.5mm  | Lead free & Halogen free | 667/800/1066 | Now        |
|         | 64M x16      | K4T1G164QF-BC(E6/F7/E7/F8) | 84-FBGA        | 7.5x12.5mm | Lead free & Halogen free | 667/800/1066 | Now        |



## DDR SDRAM COMPONENTS

| Density | Organization | Part Number        | # Pins - Package | Speed (Mbps) |
|---------|--------------|--------------------|------------------|--------------|
| 512Mb   | 128Mx4       | K4H510438J-LCB3/B0 | 66-TSOP          | 266/333      |
|         |              | K4H510438J-BCCC/B3 | 60-FBGA          | 333/400      |
|         | 64Mx8        | K4H510838J-LCCC/B3 | 66-TSOP          | 333/400      |
|         |              | K4H510838J-BCCC/B3 | 60-FBGA          | 333/400      |
|         |              | K4H511638J-LCCC/B3 | 66-TSOP          | 333/400      |

Notes: B0 = DDR266 (133MHz @ CL=2.5) A2 = DDR266 (133MHz @ CL=2) B3 = DDR333 (166MHz @ CL=2.5) CC = DDR400 (200MHz @ CL=3)

## MOBILE DRAM COMPONENTS

| Density | Type   | Organization    | Part Number     | Package                             | Power          | Production |
|---------|--------|-----------------|-----------------|-------------------------------------|----------------|------------|
| 512Mb   | MDDR   | 32Mx16          | K4X51163PK-FGD8 | 60-FBGA, 200MHz                     | 1.8V           | Now        |
|         |        | 16Mx32          | K4X51323PK-8GD8 | 90-FBGA, 200MHz                     | 1.8V           | Now        |
| 2Gb     |        | 64Mx32          | K4X2G323PD-8GD8 | 90-FBGA, 200MHz                     | 1.8V           | Now        |
| 4Gb     |        | x32 (2CS, 2CKE) | K4X4G303PD-AGD8 | 168-FBGA, 12x12 PoP, DDP, 200MHz    | 1.8V           | Now        |
| 2Gb     | LPDDR2 | 1CH x32         | K4P2G324ED-AGC1 | 168-FBGA, 12x12 PoP, MONO, 800Mbps  | 1.8V/1.2V/1.2V | Now        |
| 4Gb     |        | 1CH x32         | K4P4G324EQ-AGC2 | 168-FBGA, 12x12 PoP, MONO, 1066Mbps | 1.8V/1.2V/1.2V | Now        |
|         |        | 1CH x32         | K4P4G324EQ-FGC2 | 134-FBGA, 11x11.5, MONO, 1066Mbps   | 1.8V/1.2V/1.2V | Now        |
|         |        | 1CH x32         | K4P8G304EQ-AGC2 | 168-FBGA, 12x12 PoP, DDP, 1066Mbps  | 1.8V/1.2V/1.2V | Now        |
| 8Gb     |        | 1CH x32         | K4P8G304EQ-PGC2 | 216-FBGA, 12x12 PoP, DDP, 1066Mbps  | 1.8V/1.2V/1.2V | Now        |
|         |        | 2CH x32         | K3PE7E70QM-BGC2 | 216-FBGA, 12x12 PoP, DDP, 1066Mbps  | 1.8V/1.2V/1.2V | Now        |
|         |        | 2CH x32         | K3PE7E70QM-CGC2 | 220-FBGA, 14x14 PoP, DDP, 1066Mbps  | 1.8V/1.2V/1.2V | Now        |
| 16Gb    |        | 2CH x32         | K3PE0E00QM-BGC2 | 216-FBGA, 12x12 PoP, QDP, 1066Mbps  | 1.8V/1.2V/1.2V | Now        |
|         |        | 2CH x32         | K3PE0E00QM-CGC2 | 220-FBGA, 14x14 PoP, QDP, 1066Mbps  | 1.8V/1.2V/1.2V | Now        |
| 4Gb     | LPDDR3 | 1CH x32         | K4E4E324ED-EGCE | 178-FBGA, 11x11.5, MONO, 1600Mbps   | 1.8V/1.2V/1.2V | CS         |
| 8Gb     |        | 1CH x32         | K4E8E304ED-EGCE | 178-FBGA, 11x11.5, DDP, 1600Mbps    | 1.8V/1.2V/1.2V | CS         |
|         |        | 2CH x32         | K3QF1F10DM-AGCE | 253-FBGA, 11x11.5, DDP, 1600Mbps    | 1.8V/1.2V/1.2V | CS         |
|         |        | 2CH x32         | K3QF1F10DA-QGCE | 216-FBGA, 15x15 PoP, DDP, 1600Mbps  | 1.8V/1.2V/1.2V | Now        |
| 16Gb    |        | 1CH x32         | K4E6E304ED-EGCE | 178-FBGA, 11x11.5, QDP, 1600Mbps    | 1.8V/1.2V/1.2V | CS         |
|         |        | 2CH x32         | K3QF2F20DM-AGCE | 253-FBGA, 11x11.5, QDP, 1600Mbps    | 1.8V/1.2V/1.2V | CS         |
|         |        | 2CH x32         | K3QF2F20DM-FGCE | 256-FBGA, 14x14 PoP, QDP, 1600Mbps  | 1.8V/1.2V/1.2V | CS         |
|         |        | 2CH x32         | K3QF2F20DA-QGCE | 216-FBGA, 15x15 PoP, QDP, 1600Mbps  | 1.8V/1.2V/1.2V | Now        |

## GRAPHICS DRAM COMPONENTS

| Type  | Density | Organization | Part Number                | Package    | VDD/VDDQ    | Speed Bin (MHz)     | Production |
|-------|---------|--------------|----------------------------|------------|-------------|---------------------|------------|
| GDDR5 | 4Gb     | 128Mx32      | K4G41325FC-HC(04/03/28)    | 170-FCFBGA | 1.5V/1.5V   | 5000/6000/7000      | Now        |
|       |         |              | K4G41325FC-HC(04/03)       | 170-FCFBGA | 1.35V/1.35V | 4000/5000           | Now        |
|       | 2Gb     | 64Mx32       | K4G20325FD-FC(04/03/28)    | 170-FBGA   | 1.5V/1.5V   | 5000/6000/7000      | Now        |
|       |         |              | K4G20325FD-FC(04/03)       | 170-FBGA   | 1.35V/1.35V | 4000/5000           | Now        |
|       | 1Gb     | 32Mx32       | K4G10325FG-HC(03)          | 170-FCFBGA | 1.6V/1.6V   | 6000                | Now        |
|       |         |              | K4G10325FG-HC(05/04)       | 170-FCFBGA | 1.5V/1.5V   | 4000/5000           | Now        |
| GDDR3 | 1Gb     | 32Mx32       | K4J10324KG-HC(14/1A)       | 136-FBGA   | 1.8V/1.8V   | 1400/2000           | Now        |
| gDDR3 | 4Gb     | 256Mx16      | K4W4G1646D-BC(12/11/1A)    | 96-FCFBGA  | 1.5V/1.5V   | 1600/1866/2133      | Now        |
|       |         |              | K4W4G1646D-BC(1A)          | 96-FCFBGA  | 1.35V/1.35V | 1866                |            |
|       |         |              | K4W4G1646D-BY(12)          | 96-FCFBGA  | 1.35V/1.35V | 1600                |            |
|       |         |              | K4W4G1646B-HC(12/11/1A)    | 96-FBGA    | 1.5V/1.5V   | 1600/1866/2133      | Now        |
|       | 2Gb     | 128Mx16      | K4W2G1646Q-BC(12/11/1A)    | 96-FCFBGA  | 1.5V/1.5V   | 1600/1866/2133      | Now        |
|       |         |              | K4W2G1646Q-BC(1A)          | 96-FCFBGA  | 1.35V/1.35V | 1866                |            |
|       |         |              | K4W2G1646Q-BY(12)          | 96-FCFBGA  | 1.35V/1.35V | 1600                |            |
|       |         |              | K4W2G1646E-BC(15/12/11/1A) | 96-FBGA    | 1.5V/1.5V   | 1333/1600/1866/2133 | Now        |
|       | 1Gb     | 64Mx16       | K4W1G1646G-BC(15/12/11/1A) | 96-FBGA    | 1.5V/1.5V   | 1333/1600/1866/2133 | Now        |

Notes:

### Package

H: FBGA (Halogen Free & Lead Free) (DDR3)  
 B: FCFBGA (Halogen Free & Lead Free) (DDR3)  
 H: FCFBGA (Halogen Free & Lead Free) (GDDR5)  
 F: FBGA (Halogen Free & Lead Free) (GDDR5)

### (1) Speeds (clock cycle - speed bin)

28: 0.28ns (7000Mbps) 1A: 1.0ns (2000Mbps GDDR3)  
 03: 0.3ns (6000Mbps) 14: 1.4ns (1400Mbps GDDR3)  
 04: 0.4ns (5000Mbps) 1A: 1.0ns (2133Mbps gDDR3)  
 05: 0.5ns (4000Mbps) 11: 1.1ns (1866Mbps)  
 12: 1.25ns (1600Mbps)

## COMPONENT DRAM ORDERING INFORMATION

|                  | 1 | 2 | 3 | 4  | 5  | 6 | 7 | 8 | 9 | 10 | 11                       |
|------------------|---|---|---|----|----|---|---|---|---|----|--------------------------|
|                  | K | 4 | T | XX | XX | X | X | X | X | X  | XX                       |
| SAMSUNG Memory   |   |   |   |    |    |   |   |   |   |    | Speed                    |
| DRAM             |   |   |   |    |    |   |   |   |   |    | Temp & Power             |
| DRAM Type        |   |   |   |    |    |   |   |   |   |    | Package Type             |
| Density          |   |   |   |    |    |   |   |   |   |    | Generation               |
| Bit Organization |   |   |   |    |    |   |   |   |   |    | Interface (VDD, VDDQ)    |
|                  |   |   |   |    |    |   |   |   |   |    | Number of Internal Banks |

### 1. Memory (K)

### 2. DRAM: 4

### 3. DRAM Type

B: DDR3 SDRAM  
D: GDDR SDRAM  
G: GDDR5 SDRAM  
H: DDR SDRAM  
J: GDDR3 SDRAM  
M: Mobile SDRAM  
N: SDDR2 SDRAM  
S: SDRAM  
T: DDR SDRAM  
U: GDDR4 SDRAM  
V: Mobile DDR SDRAM Power Efficient Address  
W: SDDR3 SDRAM  
X: Mobile DDR SDRAM  
Y: XDR DRAM  
Z: Value Added DRAM

### 4. Density

10: 1G, 8K/32ms  
16: 16M, 4K/64ms  
26: 128M, 4K/32ms  
28: 128M, 4K/64ms  
32: 32M, 2K/32ms  
50: 512M, 32K/16ms  
51: 512M, 8K/64ms  
52: 512M, 8K/32ms  
54: 256M, 16K/16ms  
55: 256M, 4K/32ms  
56: 256M, 8K/64ms  
62: 64M, 2K/16ms  
64: 64M, 4K/64ms  
68: 768M, 8K/64ms  
1G: 1G, 8K/64ms  
2G: 2G, 8K/64ms  
4G: 4G, 8K/64ms

### 5. Bit Organization

02: x2  
04: x4  
06: x4 Stack (Flexframe)  
07: x8 Stack (Flexframe)

08: x8

15: x16 (2CS)

16: x16

26: x4 Stack (JEDEC Standard)

27: x8 Stack (JEDEC Standard)

30: x32 (2CS, 2CKE)

31: x32 (2CS)

32: x32

### 6. # of Internal Banks

2: 2 Banks  
3: 4 Banks  
4: 8 Banks  
5: 16 Banks

### 7. Interface ( VDD, VDDQ)

2: LVTTTL, 3.3V, 3.3V  
4: LVTTTL, 2.5V, 2.5V  
5: SSTL-2 1.8V, 1.8V  
6: SSTL-15 1.5V, 1.5V  
8: SSTL-2, 2.5V, 2.5V  
A: SSTL, 2.5V, 1.8V  
F: POD-15 (1.5V, 1.5V)  
H: SSTL\_2 DLL, 3.3V, 2.5V  
M: LVTTTL, 1.8V, 1.5V  
N: LVTTTL, 1.5V, 1.5V  
P: LVTTTL, 1.8V, 1.8V  
Q: SSTL-2 1.8V, 1.8V  
R: SSTL-2, 2.8V, 2.8V  
U: DRSL, 1.8V, 1.2V

### 8. Generation

A: 2nd Generation  
B: 3rd Generation  
C: 4th Generation  
D: 5th Generation  
E: 6th Generation  
F: 7th Generation  
G: 8th Generation  
H: 9th Generation  
I: 10th Generation  
J: 11th Generation  
K: 12th Generation  
M: 1st Generation  
N: 14th Generation  
Q: 17th Generation

### 9. Package Type

#### DDR2 DRAM

L: TSOP II (Lead-free & Halogen-free)  
H: FBGA (Lead-free & Halogen-free)  
F: FBGA for 64Mb DDR (Lead-free & Halogen-free)  
6: sTSOP II (Lead-free & Halogen-free)  
T: TSOP II  
N: sTSOP II  
G: FBGA  
U: TSOP II (Lead-free)  
V: sTSOP II (Lead-free)  
Z: FBGA (Lead-free)

#### DDR2 SDRAM

Z: FBGA (Lead-free)  
J: FBGA DDP (Lead-free)  
Q: FBGA QDP (Lead-free)  
H: FBGA (Lead-free & Halogen-free)  
M: FBGA DDP (Lead-free & Halogen-free)  
E: FBGA QDP (Lead-free & Halogen-free)  
T: FBGA DSP (Lead-free & Halogen-free, Thin)

#### DDR3 SDRAM

Z: FBGA (Lead-free)  
H: FBGA (Halogen-free & Lead-free)

#### Graphics Memory

Q: TQFP  
U: TQFP (Lead Free)  
G: 84/144 FBGA  
V: 144 FBGA (Lead Free)  
Z: 84 FBGA (Lead Free)  
T: TSOP  
L: TSOP (Lead Free)  
A: 136 FBGA  
B: 136 FBGA (Lead Free)  
H: FBGA (Hologen Free & Lead Free)  
E: 100 FBGA (Hologen Free & Lead Free)

#### SDRAM

L TSOP II (Lead-free & Halogen-free)  
N: STSOP II  
T: TSOP II  
U: TSOP II (Lead-free)  
V: sTSOP II (Lead-free)

## COMPONENT DRAM ORDERING INFORMATION

|                  | 1 | 2 | 3 | 4  | 5  | 6 | 7 | 8 | 9 | 10 | 11                       |
|------------------|---|---|---|----|----|---|---|---|---|----|--------------------------|
|                  | K | 4 | T | XX | XX | X | X | X | X | X  | XX                       |
| SAMSUNG Memory   |   |   |   |    |    |   |   |   |   |    | Speed                    |
| DRAM             |   |   |   |    |    |   |   |   |   |    | Temp & Power             |
| DRAM Type        |   |   |   |    |    |   |   |   |   |    | Package Type             |
| Density          |   |   |   |    |    |   |   |   |   |    | Generation               |
| Bit Organization |   |   |   |    |    |   |   |   |   |    | Interface (VDD, VDDQ)    |
|                  |   |   |   |    |    |   |   |   |   |    | Number of Internal Banks |

**XDR DRAM**

J: BOC(LF) P: BOC

**Mobile DRAM****Leaded/Lead Free**

G/A: 52balls FBGA Mono

R/B: 54balls FBGA Mono

X/Z: 54balls BOC Mono

J/V: 60(72)balls FBGA Mono 0.5pitch

L /F: 60balls FBGA Mono 0.8pitch

S/D: 90balls FBGA

**Monolithic (11mm x 13mm)**

F/H: Smaller 90balls FBGA Mono

Y/P: 54balls CSP DDP

M/E: 90balls FBGA DDP

**DDR2 SDRAM**

CC: DDR2-400 (200MHz @ CL=3, tRCD=3, tRP=3)

D5: DDR2-533 (266MHz @ CL=4, tRCD=4, tRP=4)

E6: DDR2-667 (333MHz @ CL=5, tRCD=5, tRP=5)

F7: DDR2-800 (400MHz @ CL=6, tRCD=6, tRP=6)

E7: DDR2-800 (400MHz @ CL=5, tRCD=5, tRP=5)

**DDR3 SDRAM**

F7: DDR3-800 (400MHz @ CL=6, tRCD=6, tRP=6)

F8: DDR3-1066 (533MHz @ CL=7, tRCD=7, tRP=7)

G8: DDR3-1066 (533MHz @ CL=8, tRCD=8, tRP=8)

H9: DDR3-1333 (667MHz @ CL=9, tRCD=9, tRP=9)

K0: DDR3-1600 (800MHz @ CL=11, tRCD=11, tRP=11)

MA: DDR3-1866 (933MHz @ CL=13, tRCD=13, tRP=13)

NB: DDR3-2133 (1067MHz @ CL=14, tRCD=14, tRP=14)

**Graphics Memory**

18: 1.8ns (550MHz)

04: 0.4ns (2500MHz)

20: 2.0ns (500MHz)

05: 0.5ns (2000MHz)

22: 2.2ns (450MHz)

5C: 0.56ns (1800MHz)

25: 2.5ns (400MHz)

06: 0.62ns (1600MHz)

2C: 2.66ns (375MHz)

6A: 0.66ns (1500MHz)

2A: 2.86ns (350MHz)

07: 0.71ns (1400MHz)

33: 3.3ns (300MHz)

7A: 0.77ns (1300MHz)

36: 3.6ns (275MHz)

08: 0.8ns (1200MHz)

40: 4.0ns (250MHz)

09: 0.9ns (1100MHz)

45: 4.5ns (222MHz)

1 : 1.0ns (1000MHz)

50/5A: 5.0ns (200MHz)

1 : 1.1ns (900MHz)

55: 5.5ns (183MHz)

12: 1.25ns (800MHz)

60: 6.0ns (166MHz)

14: 1.4ns (700MHz)

16: 1.6ns (600MHz)

**SDRAM (Default CL=3)**

50: 5.0ns (200MHz CL=3)

60: 6.0ns (166MHz CL=3)

67: 6.7ns

75: 7.5ns PC133 (133MHz CL=3)

**XDR DRAM**

A2: 2.4Gbps, 36ns, 16Cycles

B3: 3.2Gbps, 35ns, 20Cycles

C3: 3.2Gbps, 35ns, 24Cycles

C4: 4.0Gbps, 28ns, 24Cycles

DS: Daisychain Sample

**Mobile-SDRAM**

60: 166MHz, CL 3

75: 133MHz, CL 3

80: 125MHz, CL 3

1H: 105MHz, CL 2

1L: 105MHz, CL 3

15: 66MHz, CL 2 &amp; 3

**Mobile-DDR**

C3: 133MHz, CL 3

C2: 100MHz, CL 3

C0: 66MHz, CL 3

Note: All Lead-free and Halogen-free products are in compliance with RoHS

**10. Temp & Power - COMMON  
(Temp, Power)**

C: Commercial, Normal (0°C – 95°C) &amp; Normal Power

C: (Mobile Only) Commercial (-25 ~ 70°C), Normal Power

J: Commercial, Medium

L: Commercial, Low (0°C – 95°C) &amp; Low Power

L: (Mobile Only) Commercial, Low, i-TCSR

F: Commercial, Low, i-TCSR &amp; PASR &amp; DS

E: Extended (-25~85°C), Normal

N: Extended, Low, i-TCSR

G: Extended, Low, i-TCSR &amp; PASR &amp; DS

I: Industrial, Normal (-40°C – 85°C) &amp; Normal Power

P: Industrial, Low (-40°C – 85°C) &amp; Low Power

H: Industrial, Low, i-TCSR &amp; PASR &amp; DS

**11. Speed (Wafer/Chip Biz/BGD: 00)****DDR SDRAM**

CC: DDR400 (200MHz @ CL=3, tRCD=3, tRP=3)

B3: DDR333 (166MHz @ CL=2.5, tRCD=3, tRP=3) \*1

A2: DDR266 (133MHz @ CL=2, tRCD=3, tRP=3)

B0: DDR266 (133MHz @ CL=2.5, tRCD=3, tRP=3)

Note 1: "B3" has compatibility with "A2" and "B0"

## MODULE DRAM ORDERING INFORMATION

|                     | 1 | 2 | 3  | 4 | 5  | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13           |
|---------------------|---|---|----|---|----|---|---|---|---|----|----|----|--------------|
|                     | M | X | XX | T | XX | X | X | X | X | X  | X  | XX | X            |
| SAMSUNG Memory      |   |   |    |   |    |   |   |   |   |    |    |    | AMB Vendor   |
| DIMM                |   |   |    |   |    |   |   |   |   |    |    |    | Speed        |
| Data bits           |   |   |    |   |    |   |   |   |   |    |    |    | Temp & Power |
| DRAM Component Type |   |   |    |   |    |   |   |   |   |    |    |    | PCB Revision |
| Depth               |   |   |    |   |    |   |   |   |   |    |    |    | Package      |
| Number of Banks     |   |   |    |   |    |   |   |   |   |    |    |    | Generation   |
| Bit Organization    |   |   |    |   |    |   |   |   |   |    |    |    |              |

### 1. Memory Module: M

### 2. DIMM Type

- 3: DIMM
- 4: SODIMM

### 3. Data bits

- 12: x72 184pin Low Profile Registered DIMM
- 63: x63 PC100/PC133 μSODIMM with SPD for 144pin
- 64: x64 PC100/PC133 SODIMM with SPD for 144pin (Intel/JEDEC)
- 66: x64 Unbuffered DIMM with SPD for 144pin/168pin (Intel/JEDEC)
- 68: x64 184pin Unbuffered DIMM
- 70: x64 200pin Unbuffered SODIMM
- 71: x64 204pin Unbuffered SODIMM
- 74: x72/ECC Unbuffered DIMM with SPD for 168pin (Intel/JEDEC)
- 77: x72/ECC PLL + Register DIMM with SPD for 168pin (Intel PC100)
- 78: x64 240pin Unbuffered DIMM
- 81: x72 184pin ECC unbuffered DIMM
- 83: x72 184pin Registered DIMM
- 90: x72/ECC PLL + Register DIMM
- 91: x72 240pin ECC unbuffered DIMM
- 92: x72 240pin VLP Registered DIMM
- 93: x72 240pin Registered DIMM
- 95: x72 240pin Fully Buffered DIMM with SPD for 168pin (JEDEC PC133)

### 4. DRAM Component Type

- B: DDR3 SDRAM (1.5V VDD)
- L: DDR SDRAM (2.5V VDD)
- S: SDRAM
- T: DDR2 SDRAM (1.8V VDD)

### 5. Depth

- 09: 8M (for 128Mb/512Mb)
- 17: 16M (for 128Mb/512Mb)
- 16: 16M
- 28: 128M
- 29: 128M (for 128Mb/512Mb)
- 32: 32M
- 33: 32M (for 128Mb/512Mb)
- 51: 512M
- 52: 512M (for 512Mb/2Gb)
- 56: 256M
- 57: 256M (for 512Mb/2Gb)
- 59: 256M (for 128Mb/512Mb)
- 64: 64M
- 65: 64M (for 128Mb/512Mb)
- 1G: 1G
- 1K: 1G (for 2Gb)

### 6. # of Banks in Comp. & Interface

- 1: 4K/64mxRef., 4Banks & SSTL-2
- 2 : 8K/64ms Ref., 4Banks & SSTL-2
- 2: 4K/64ms Ref., 4Banks & LVTTTL (SDR Only)
- 5: 8K/64ms Ref., 4Banks & LVTTTL (SDR Only)
- 5: 4Banks & SSTL-1.8V
- 6: 8Banks & SSTL-1.8V

### 7. Bit Organization

- 0: x 4
- 3: x 8
- 4: x16
- 6: x 4 Stack (JEDEC Standard)
- 7: x 8 Stack (JEDEC Standard)
- 8: x 4 Stack
- 9: x 8 Stack

### 8. Generation

- A: 2nd Gen.
- B: 3rd Gen.
- C: 4th Gen.
- D: 5th Gen.
- E: 6th Gen.
- F: 7th Gen.
- G: 8th Gen.
- M: 1st Gen.
- Q: 17th Gen.

### 9. Package

- E: FBGA QDP (Lead-free & Halogen-free)
- G: FBGA
- H: FBGA (Lead-free & Halogen-free)
- J: FBGA DDP (Lead-free)
- M: FBGA DDP (Lead-free & Halogen-free)
- N: sTSOP
- Q: FBGA QDP (Lead-free)
- T: TSOP II (400mil)
- U: TSOP II (Lead-Free)
- V: sTSOP II (Lead-Free)
- Z: FBGA (Lead-free)

### 10. PCB Revision

- 0: Mother PCB
- 1: 1st Rev
- 2: 2nd Rev.
- 3: 3rd Rev.
- 4: 4th Rev.
- A: Parity DIMM
- S: Reduced PCB
- U: Low Profile DIMM

### 11. Temp & Power

- C: Commercial Temp. (0°C ~ 95°C) & Normal Power
- L: Commercial Temp. (0°C ~ 95°C) & Low Power

### 12. Speed

- CC: (200MHz @ CL=3, tRCD=3, tRP=3)
- D5: (266MHz @ CL=4, tRCD=4, tRP=4)
- E6: (333MHz @ CL=5, tRCD=5, tRP=5)
- F7: (400MHz @ CL=6, tRCD=6, tRP=6)
- E7: (400MHz @ CL=5, tRCD=5, tRP=5)
- F8: (533MHz @ CL=7, tRCD=7, tRP=7)
- G8: (533MHz @ CL=8, tRCD=8, tRP=8)
- H9: (667MHz @ CL=9, tRCD=9, tRP=9)
- K0: (800MHz @ CL=10, tRCD=10, tRP=10)
- 7A: (133MHz CL=3/PC100 CL2)

### 13. AMB Vendor for FBDIMM

- 0, 5: Intel
- 1, 6, 8: IDT
- 9: Montage

Note: All Lead-free and Halogen-free products are in compliance with RoHS

## SLC FLASH

| Density  | Technology | Part Number      | Package Type          | Org. | Vol(V) | Status                                                                             |
|----------|------------|------------------|-----------------------|------|--------|------------------------------------------------------------------------------------|
| 16Gb QDP | 21nm SDR   | K9WAG08U1E-SCB0* | TSOP1-LF/HF           | x8   | 3.3    | Sampling now                                                                       |
|          |            | K9WAG08U1E-SIB0* | TSOP1-LF/HF, i-temp   | x8   | 3.3    | Sampling now                                                                       |
| 8Gb DDP  | 21nm SDR   | K9K8G08U0E-SCB0* | TSOP1-LF/HF           | x8   | 3.3    | Sampling now                                                                       |
|          |            | K9K8G08U0E-SIB0* | TSOP1-LF/HF, i-temp   | x8   | 3.3    | Sampling now                                                                       |
| 4Gb      | 21nm SDR   | K9F4G08U0E-SCB0* | TSOP1 LF/HF           | x8   | 3.3    | Sampling now                                                                       |
|          |            | K9F4G08U0E-SIB0* | TSOP1 LF/HF, i-temp   | x8   | 3.3    | Sampling now                                                                       |
| 1Gb      | 21nm SDR   | K9F1G08U0E-SCB0* | TSOP1-LF/HF           | x8   | 3.3    | CS Sept'13                                                                         |
|          |            | K9F1G08U0E-SIB0* | TSOP1-LF/HF, i-temp   | x8   | 3.3    | CS Sept'13                                                                         |
|          |            | K9F1G08U0E-BCB0* | FBGA-LF/HF            | x8   | 3.3    | CS Sept'13                                                                         |
|          |            | K9F1G08U0E-BIB0* | FBGA-LF/HF, i-temp    | x8   | 3.3    | CS Sept'13                                                                         |
| 16Gb QDP | 42nm SDR   | K9WAG08U1D-SCB0* | TSOP1                 | x8   | 3.3    | <b>42nm SLC EOL Notice:</b><br>Last-time buy: Dec 2013<br>Last-time ship: Mar 2014 |
|          |            | K9WAG08U1D-SIB0* | TSOP1                 | x8   | 3.3    |                                                                                    |
| 8Gb DDP  | 42nm SDR   | K9K8G08U0D-SCB0* | TSOP-LF/HF            | x8   | 3.3    |                                                                                    |
|          |            | K9K8G08U0D-SIB0* | TSOP-LF/HF, i-temp    | x8   | 3.3    |                                                                                    |
| 4Gb      | 42nm SDR   | K9F4G08U0D-SCB0* | TSOP1 HF & LF         | x8   | 3.3    |                                                                                    |
|          |            | K9F4G08U0D-SIB0* | TSOP1 HF & LF, i-temp | x8   | 3.3    |                                                                                    |
| 2Gb      | 42nm SDR   | K9F2G08U0C-SCB0* | TSOP-LF/HF            | x8   | 3.3    |                                                                                    |
|          |            | K9F2G08U0C-SIB0* | TSOP-LF/HF, i-temp    | x8   | 3.3    |                                                                                    |
| 1Gb      | 42nm SDR   | K9F1G08U0D-SCB0* | TSOP-LF/HF            | x8   | 3.3    |                                                                                    |
|          |            | K9F1G08U0D-SIB0* | TSOP-LF/HF, i-temp    | x8   | 3.3    |                                                                                    |

Please contact your local Samsung sales representative for latest product offerings.

Note: All parts are lead free

## MLC FLASH

| Type | Density   | Technology | Part Number        | Package Type | Org. | Vol(V)  | Status                                                                                  |
|------|-----------|------------|--------------------|--------------|------|---------|-----------------------------------------------------------------------------------------|
| 2bit | 512Gb ODP | 21nm DDR   | K9PHGY8S5A-HCK0000 | 132BGA       | x8   | 3.3/1.8 | <b>21nm 2bit MLC EOL Notice:</b><br>Last-time buy: Nov 2013<br>Last-time ship: Feb 2014 |
|      | 256Gb QDP | 21nm DDR   | K9HFGY8S5A-HCK0000 | 132BGA       | x8   | 3.3/1.8 |                                                                                         |
|      | 128Gb DDP | 21nm DDR   | K9LDGY8S1A-HCK0000 | 132BGA       | x8   | 3.3/1.8 |                                                                                         |
|      | 64Gb mono | 21nm DDR   | K9GCGY8S0A-HCK0000 | 132BGA       | x8   | 3.3/1.8 |                                                                                         |
|      | 32Gb mono | 21nm SDR   | K9GBG08U0B-SCB0000 | 48TSOP       | x8   | 3.3     |                                                                                         |
|      |           | 21nm DDR   | K9GBGY8U0B-HCK0000 | 132BGA       | x8   | 3.3/1.8 |                                                                                         |
| 3bit | 256Gb QDP | 21nm DDR   | K9CFGD8U1A-SCB0000 | 48TSOP       | x8   | 3.3     | <b>21nm 3bit MLC EOL Notice:</b><br>Last-time buy: Nov 2013<br>Last-time ship: Feb 2014 |
|      | 128Gb DDP | 21nm DDR   | K9BDGD8U0A-SCB0000 | 48TSOP       | x8   | 3.3     |                                                                                         |
|      | 64Gb mono | 21nm DDR   | K9ACGD8U0A-SCB0000 | 48TSOP       | x8   | 3.3     |                                                                                         |
|      | 32Gb mono | 21nm DDR   | K9ABGD8U0C-SCB0000 | 48TSOP       | x8   | 3.3     |                                                                                         |
|      |           |            |                    |              |      |         |                                                                                         |

Please contact your local Samsung sales representative for latest product offerings.

Note: All parts are lead-free &amp; halogen-free

## INDUSTRIAL CARDS

| Density | Part Number        | Sequential Reads | Sequential Writes |
|---------|--------------------|------------------|-------------------|
| 8GB     | MMCAF08G3ACA-QMWCV | 24 MB/s          | 16MB/s            |
| 16GB    | MMCAF16GWACA-QMWCV | 24 MB/s          | 21MB/s            |

Please contact your local Samsung sales representative for part numbers and latest product offerings.



## microSD FLASH CARDS

| Application | Density | Part Number        | Class | Ultra High Speed (UHS) |
|-------------|---------|--------------------|-------|------------------------|
| uSD Cards   | 2GB     | MMAUR02G3ACA-QNJ00 | CL4   |                        |
|             | 4GB     | MMBTR04G3CCA-QNJ00 | CL4   | UHS 104                |
|             | 8GB     | MMCTR08G3ACH-QNJ00 | CL4   | UHS 104                |
|             | 16GB    | MMCTR16GUACJ-SAC00 | CL10  | UHS 104                |
|             | 32GB    | MMCTR32GUACJ-SAC00 | CL10  | UHS 104                |
|             | 64GB    | MMCTR64GUACJ-SAC00 | CL10  | UHS 104                |

Please contact your local Samsung sales representative for part numbers and latest product offerings.

## microSD Card Key Features

- Durable and high-performance data storage for your secure digital (SD)-enabled handset and tablet designs
- Fastest performing, sturdiest and most dependable memory cards on the market today
- 10nm-class leading-edge NAND chips, advanced controller designs and state-of-the-art firmware
- 4GB ~ 64GB capacities, UHS-104, Class 6/10

### A variety of storage capacities to fit all usage needs

| Usage           | 4GB        | 8GB          | 16GB         | 32GB         | 64GB          |
|-----------------|------------|--------------|--------------|--------------|---------------|
| <b>Photo*</b>   | 750 photos | 1,500 photos | 3,000 photos | 6,000 photos | 12,000 photos |
| <b>Video**</b>  | 30 mins    | 60 mins      | 120 mins     | 240 mins     | 480 mins      |
| <b>Music***</b> | 940 songs  | 1,880 songs  | 3,760 songs  | 7,520 songs  | 15,040 songs  |

\*\*Photo: 20 Megapixels (5472x2448) \*\*Video: H264@1080p \*\*\*Music: 3.5 minute MP3 song

## High Capacities

With Samsung's full lineup of microSD cards, you can capture more photos and videos, and download more media files and apps to your mobile device without worrying about speed or capacity.



## Extreme Performance

All of Samsung's microSD cards feature the highest quality NAND and are available with UHS-I support, offering Samsung's fastest speeds at up to 80MB/s Read and 20MB/s Write—ideal for use in high-end smart phones and tablet PCs.



## MAINSTREAM eMMC

| Density | Flash  | MMC* | Class | Part Number     | Seq R/W Perf (MB/s) | Random R/W IOPS | Package Size (mm) | C/S |
|---------|--------|------|-------|-----------------|---------------------|-----------------|-------------------|-----|
| 4GB     | 32Gb*1 | 5.0  | 200   | KLM4G1YEMD-C031 | 100/6               | 2500/200        | 11.5x13x0.8       | Oct |
| 8GB     | 64Gb*1 | 5.0  | 200   | KLM8G1WEMB-B031 | 100/6               | 2500/200        | 11.5x13x0.8       | Sep |
| 16GB    | 64Gb*2 | 5.0  | 700   | KLMAG2WEMB-B031 | 170/11              | 4000/500        | 11.5x13x0.8       | Oct |
| 32GB    | 64Gb*4 | 5.0  | 1500  | KLMBG4WEMC-B031 | 200/50              | 4000/1500       | 11.5x13x1.0       | Sep |
| 64GB    | 64Gb*8 | 5.0  | 1500  | KLMCG8WEMC-B031 | 200/50              | 4000/1500       | 11.5x13x1.0       | Oct |

\*MMC5.0 is backwards compatible with 4.5 & 4.41

## eMMC-PRO (HIGH PERFORMANCE)

| Density | Flash   | MMC* | Class | Part Number     | Seq R/W Perf (MB/s) | Random R/W IOPS | Package Size (mm) | C/S |
|---------|---------|------|-------|-----------------|---------------------|-----------------|-------------------|-----|
| 4GB     | 32Gb*1  | 5.0  | 700   | KLM4G1FEAC-B031 | 150/10              | 4000/700        | 11x10x0.8         | Now |
| 8GB     | 64Gb*1  | 5.0  | 700   | KLMAG2GEAC-B031 | 180/20              | 4000/700        | 11.5x13x1.0       | Now |
| 16GB    | 64Gb*2  | 5.0  | 2000  | KLMAG2GEAC-B031 | 240/40              | 6000/2500       | 11.5x13x1.0       | Now |
| 32GB    | 64Gb*4  | 5.0  | 2000  | KLMBG4GEAC-B031 | 240/60              | 6000/2500       | 11.5x13x1.0       | Now |
| 64GB    | 64Gb*8  | 5.0  | 2000  | KLMCG8GEAC-B031 | 240/60              | 6000/2500       | 11.5x13x1.2       | Now |
| 128GB   | 64Gb*16 | 4.5  | 2000  | KLMDGAGEAC-B001 | 150/50              | 4000/2000       | 11.5x13x1.4       | Now |

\*MMC5.0 is backwards compatible with 4.5 & 4.41

## eMMC Key Features

- Industry's fastest eMMC
- Fully-managed NAND
- Low active & standby power
- High density in small form factor (11.5x13mm pkg)
- 4GB to 128GB capacities
- JEDEC standard MMC 4.51/5.0
- Leading edge 10nm-class NAND Flash
- Advanced controller & firmware design

### Performance Specs

| 32GB, 64GB      | eMMC 4.5       | eMMC 5.0       |
|-----------------|----------------|----------------|
| Interface Speed | 200MB/s        | 400MB/s        |
| Random R/W      | 3500/2000 IOPS | 7000/2500 IOPS |
| Sequential R/W  | 150/50 MB/s    | 250/60 MB/s    |

\* Device performance condition: x8 Bus, Cache-On mode, without host overhead.

### Applications

eMMC is the ideal flash solution for tablets and smartphones, as well as applications from eReaders, HD cameras and smart TVs to PNDs, multi-media players and gaming devices.

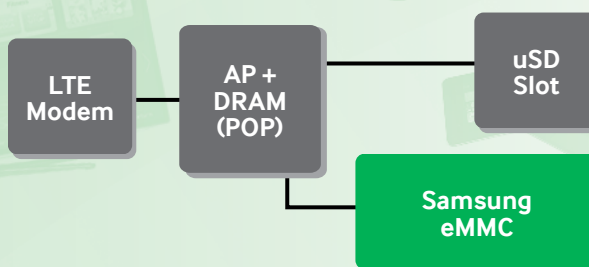
## Industry-Leading Smartphone and Tablet Design

### Specifications

- Density: 4GB to 128GB
- Class: 200/700/1500/2000\*
- Flash: 32Gb/64Gb
- Package Type: FBGA
- Package Size: 11x10mm, 11.5x13mm
- eMMC: 4.5/5.0

\* Class = Random Write IOPS

### Simple Block Diagram



## SOLID STATE DRIVES (SSD)

| Drive Type             | Drive Name | Interface           | Form Factor   | Connector  | Component   | Power-loss Protection | Density | Part Number        | Status |
|------------------------|------------|---------------------|---------------|------------|-------------|-----------------------|---------|--------------------|--------|
| Client PC/<br>Embedded | PM841      | SATA III - 6Gb/s    | mSATA MO-300  | Mini PCI-E | 3-bit MLC   | No                    | 128GB   | MZMTD128HAFV-00000 | EOL    |
|                        |            |                     |               |            |             |                       | 256GB   | MZMTD256HAGM-00000 | EOL    |
|                        |            |                     |               |            |             |                       | 512GB   | MZMTD512HAGL-00000 | EOL    |
|                        | SM841      | SATA III - 6Gb/s    | mSATA MO-300  | Mini PCI-E | 2-bit MLC   | No                    | 128GB   | MZMPD128HAFV-00000 | EOL    |
|                        |            |                     |               |            |             |                       | 256GB   | MZMPD256HAGM-00000 | EOL    |
|                        |            |                     |               |            |             |                       | 512GB   | MZMPD512HAGL-00000 | EOL    |
|                        | XP941      | PCIe - SATAe        | M.2 (22x80mm) | M.2        | 2-bit MLC   | No                    | 128GB   | MZHPU128HCGM-00000 | MP     |
|                        |            |                     |               |            |             |                       | 256GB   | MZHPU256HCGL-00000 | MP     |
|                        |            |                     |               |            |             |                       | 512GB   | MZHPU512HCGL-00000 | MP     |
| Data Center            | PM843      | SATA III - 6Gb/s    | 2.5" 7mmT     | SF-8223    | 3-bit MLC   | No                    | 120GB   | MZ7TD120HAFV-000DA | EOL    |
|                        |            |                     |               |            |             |                       | 240GB   | MZ7TD240HAFV-000DA | EOL    |
|                        |            |                     |               |            |             |                       | 480GB   | MZ7TD480HAGM-000DA | EOL    |
|                        | SM843      | SATA III - 6Gb/s    | 2.5" 7mmT     | SF-8223    | 2-bit MLC   | No                    | 120GB   | MZ7PD120HAFV-000DA | EOL    |
|                        |            |                     |               |            |             |                       | 240GB   | MZ7PD240HAFV-000DA | EOL    |
|                        |            |                     |               |            |             |                       | 480GB   | MZ7PD480HAGM-000DA | EOL    |
|                        | SM843T     | SATA III - 6Gb/s    | 2.5" 7mmT     | SF-8223    | 2-bit MLC   | Yes                   | 120GB   | MZ7WD120HCFV-00003 | MP Q4  |
|                        |            |                     |               |            |             |                       | 240GB   | MZ7WD240HCFV-00003 | MP Q4  |
|                        |            |                     |               |            |             |                       | 480GB   | MZ7WD480HCGM-00003 | MP Q4  |
|                        |            |                     |               |            |             |                       | 960GB   | MZ7WD960HCGP-00003 | MP Q4  |
| Storage Enclosure      | SM1625     | SAS Gen 2.0 - 6Gb/s | 2.5" 15mmT    | SFF-8482   | 2-bit E-MLC | Yes                   | 100GB   | MZ6ER100HAFV-00003 | EOL    |
|                        |            |                     |               |            |             |                       | 200GB   | MZ6ER200HAGM-00003 | EOL    |
|                        |            |                     |               |            |             |                       | 400GB   | MZ6ER400HAGL-00003 | EOL    |
|                        |            |                     |               |            |             |                       | 800GB   | MZ6ER800HAGL-00003 | EOL    |

## FLASH PRODUCTS ORDERING INFORMATION

|                      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15                  |
|----------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|---------------------|
|                      | K | 9 | X | X | X | X | X | X | X | X  | -  | X  | X  | X  | X                   |
| SAMSUNG Memory       |   |   |   |   |   |   |   |   |   |    |    |    |    |    | Pre-Program Version |
| NAND Flash           |   |   |   |   |   |   |   |   |   |    |    |    |    |    | Customer Bad Block  |
| Small Classification |   |   |   |   |   |   |   |   |   |    |    |    |    |    | Temp                |
| Density              |   |   |   |   |   |   |   |   |   |    |    |    |    |    | Package             |
| Density              |   |   |   |   |   |   |   |   |   |    |    |    |    |    | ---                 |
| Organization         |   |   |   |   |   |   |   |   |   |    |    |    |    |    | Generation          |
| Organization         |   |   |   |   |   |   |   |   |   |    |    |    |    |    | Mode                |
| Vcc                  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |                     |

## 1. Memory (K)

## 2. NAND Flash : 9

## 3. Small Classification

(SLC : Single Level Cell, MLC : Multi Level Cell)

7 : SLC eMMC  
 8 : MLC eMMC  
 F : SLC Normal  
 G : MLC Normal  
 H : MLC QDP  
 K : SLC DDP  
 L : MLC DDP  
 M : MLC DSP  
 N : SLC DSP  
 P : MLC 8 Die Stack  
 Q : SLC 8 Die Stack  
 S : SLC Single SM  
 T : SLC SINGLE (S/B)  
 U : 2 Stack MSP  
 W : SLC 4 Die Stack

## 4~5. Density

12 : 512M  
 56 : 256M  
 1G : 1G  
 2G : 2G  
 4G : 4G  
 8G : 8G  
 AG : 16G  
 BG : 32G  
 CG : 64G  
 DG : 128G  
 EG : 256G  
 LG : 24G  
 NG : 96G  
 ZG : 48G  
 00 : NONE

## 6~7. Organization

00 : NONE  
 08 : x8  
 16 : x16

## 8. Vcc

A : 1.65V~3.6V      B : 2.7V (2.5V~2.9V)  
 C : 5.0V (4.5V~5.5V)      D : 2.65V (2.4V~2.9V)  
 E : 2.3V~3.6V      R : 1.8V (1.65V~1.95V)  
 Q : 1.8V (1.7V~1.95V)      T : 2.4V~3.0V  
 U : 2.7V~3.6V      V : 3.3V (3.0V~3.6V)  
 W : 2.7V~5.5V, 3.0V~5.5V      0 : NONE

## 9. Mode

0 : Normal  
 1 : Dual nCE & Dual R/nB  
 3 : Tri/CE & Tri R/B  
 4 : Quad nCE & Single R/nB  
 5 : Quad nCE & Quad R/nB  
 9 : 1st block OTP  
 A : Mask Option 1  
 L : Low grade

## 10. Generation

M : 1st Generation  
 A : 2nd Generation  
 B : 3rd Generation  
 C : 4th Generation  
 D : 5th Generation

## 11. ----

## 12. Package

A : COB  
 B : FBGA (Halogen-Free, Lead-Free)  
 C : CHIP BIZ D : 63-TBGA  
 F : WSOP (Lead-Free) G : FBGA  
 H : TBGA (Lead-Free)  
 I : ULGA (Lead-Free) (12\*17)  
 J : FBGA (Lead-Free)  
 L : ULGA (Lead-Free) (14\*18)  
 M : TLGA N : TLGA2  
 P : TSOP1 (Lead-Free)  
 Q : TSOP2 (Lead-Free)  
 S : TSOP1 (Halogen-Free, Lead-Free)  
 T : TSOP2 U : COB (MMC)  
 V : WSOP W : Wafer  
 Y : TSOP1 Z : WELP (Lead-Free)

## 13. Temp

C : Commercial I : Industrial  
 0 : NONE (Containing Wafer, CHIP, BIZ, Exception handling code)

## 14. Customer Bad Block

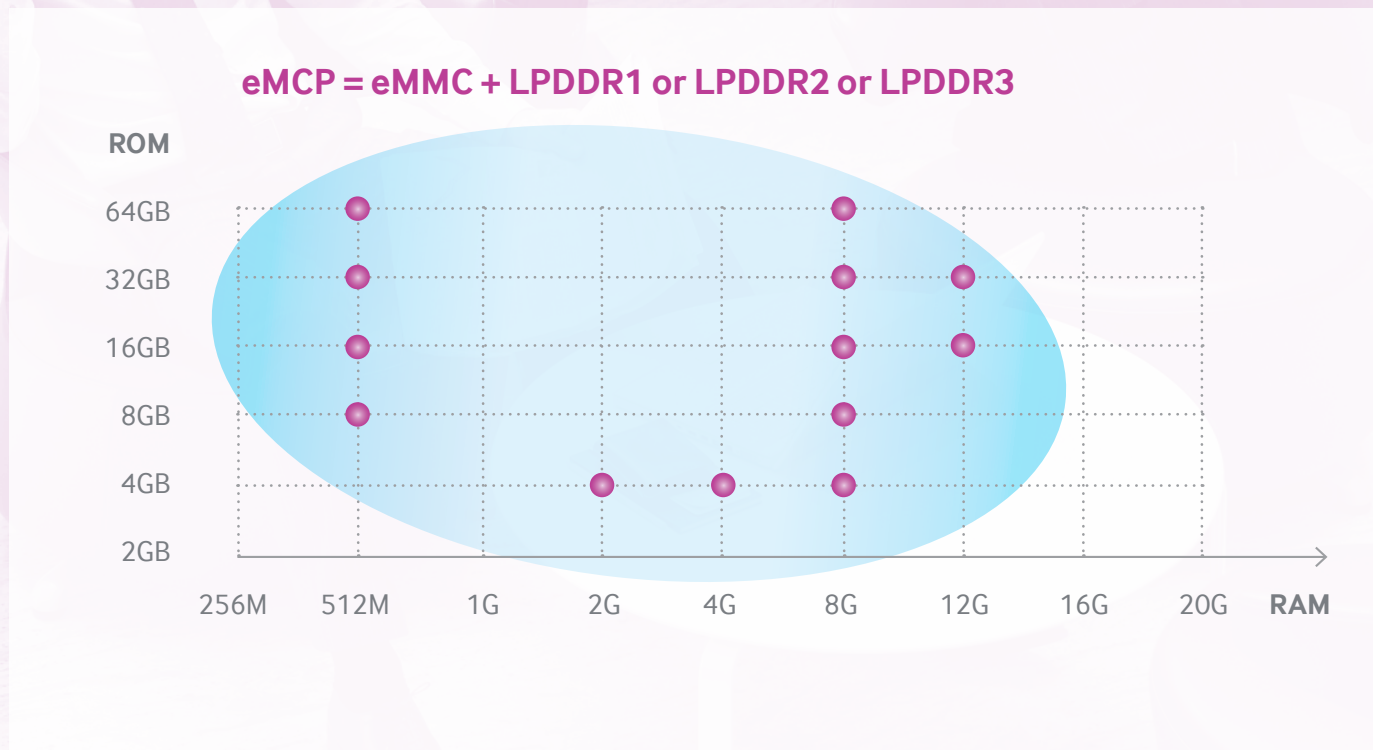
B : Include Bad Block  
 D : Daisychain Sample  
 L : 1~5 Bad Block  
 N : ini. 0 blk, add. 10 blk  
 S : All Good Block  
 0 : NONE (Containing Wafer, CHIP, BIZ, Exception handling code)

## 15. Pre-Program Version

0 : None  
 Serial (1~9, A~Z)

Samsung has a vast portfolio of eMCP products for a variety of devices, such as mobile phones and tablets. The following illustration shows Samsung's lineup of eMCP memory solutions, which can be deployed in almost any application.

→ Samsung eMCP product suite with different densities and types of Mobile DRAM and eMMC





## eMCP: eMMC + LPDDR3

| Memory       | eMMC Density | DRAM Density/Organization | Voltage (eMMC-DRAM)   | Package           |
|--------------|--------------|---------------------------|-----------------------|-------------------|
| eMMC & MDRAM | 4GB          | 4Gb*2 (x32, 1ch, 2CS)     | 3.3V/1.8V - 1.8V/1.2V | 221FBGA 11.5x13mm |
|              | 8GB          | 4Gb*2 (x32, 1ch, 2CS)     | 3.3V/1.8V - 1.8V/1.2V | 221FBGA 11.5x13mm |
|              | 16GB         | 4Gb*2 (x32, 1ch, 2CS)     | 3.3V/1.8V - 1.8V/1.2V | 221FBGA 11.5x13mm |

## eMCP: eMMC + LPDDR2

| Memory       | eMMC Density | DRAM Density/Organization | Voltage (eMMC-DRAM)   | Package           |
|--------------|--------------|---------------------------|-----------------------|-------------------|
| eMMC & MDRAM | 4GB          | 2Gb (x32)                 | 3.3V/1.8V - 1.8V/1.2V | 162FBGA 11.5x13mm |
|              |              | 4Gb (x32)                 | 3.3V/1.8V - 1.8V/1.2V | 162FBGA 11.5x13mm |
|              |              | 4Gb*2 (x32, 1ch, 2CS)     | 3.3V/1.8V - 1.8V/1.2V | 162FBGA 11.5x13mm |
|              | 8GB          | 4Gb*2 (x32, 1ch, 2CS)     | 3.3V/1.8V - 1.8V/1.2V | 162FBGA 11.5x13mm |
|              | 16GB         | 4Gb*2 (x32, 1ch, 2CS)     | 3.3V/1.8V - 1.8V/1.2V | 162FBGA 11.5x13mm |
|              |              | 4Gb*4 (x32, 1ch, 2CS)     | 3.3V/1.8V - 1.8V/1.2V | 162FBGA 11.5x13mm |
|              | 32GB         | 4Gb*2 (x32, 1ch, 2CS)     | 3.3V/1.8V - 1.8V/1.2V | 162FBGA 11.5x13mm |
|              |              | 4Gb*4 (x32, 1ch, 2CS)     | 3.3V/1.8V - 1.8V/1.2V | 162FBGA 11.5x13mm |
|              | 64GB         | 4Gb*2 (x32, 1ch, 2CS)     | 3.3V/1.8V - 1.8V/1.2V | 162FBGA 11.5x13mm |

## eMCP: eMMC + MDDR

| Memory       | eMMC Density | DRAM Density/Organization | Voltage (eMMC-DRAM) | Package           |
|--------------|--------------|---------------------------|---------------------|-------------------|
| eMMC & MDRAM | 4GB          | 2Gb*2 (x32, 2CS/CKE)      | 3.3V/1.8V - 1.8V    | 153FBGA 11.5x13mm |
|              |              | 2Gb*4 (x32, 2CS/CKE)      | 3.3V/1.8V - 1.8V    | 153FBGA 11.5x13mm |
|              | 8GB          | 512Mb (x16)               | 3.3V/1.8V - 1.8V    | 153FBGA 11.5x13mm |
|              |              | 2Gb*4 (x32, 2CS/CKE)      | 3.3V/1.8V - 1.8V    | 153FBGA 11.5x13mm |
|              | 16GB         | 512Mb (x16)               | 3.3V/1.8V - 1.8V    | 153FBGA 11.5x13mm |
|              | 32GB         | 512Mb (x16)               | 3.3V/1.8V - 1.8V    | 153FBGA 11.5x13mm |
|              | 64GB         | 512Mb (x16)               | 3.3V/1.8V - 1.8V    | 153FBGA 11.5x13mm |



## SAMSUNG SOLID STATE DRIVES

### STANDARD DATA CENTER SERIES

Read-Intensive  
Environments

### PRO DATA CENTER SERIES

High-Read and  
Write Environments

### DELUXE ENTERPRISE SERIES

High-Write  
Environments

|                                            | Samsung PM843         | Samsung SM843T                                    | Samsung SM1625                    |
|--------------------------------------------|-----------------------|---------------------------------------------------|-----------------------------------|
| <b>Form Factor</b>                         | 2.5 inches            | 2.5 inches                                        | 2.5 inches                        |
| <b>Capacity (GB)</b>                       | 120/240/480           | 120/240/480/960 GB                                | 100/200/400/800                   |
| <b>Host Interface</b>                      | Serial ATA 3 (6 Gb/s) | Serial ATA 3 (6 Gb/s)                             | SAS (6 Gb/s)                      |
| <b>MTBF</b>                                | 1.5 Million Hours     | 2,000,000 hours                                   | 2,000,000 hours                   |
| <b>Uncorrectable Bit Error Rate (UBER)</b> | 1x10 <sup>16</sup>    | 1x10 <sup>17</sup>                                | 1x10 <sup>17</sup>                |
| <b>Power Consumption (Active)</b>          | 4.2W                  | 3.4W                                              | 9W                                |
| <b>Power Consumption (Idle)</b>            | 300 mW                | 300 mW                                            | 4W                                |
| <b>Random Read</b>                         | Up to 60,000 IOPS     | Up to 98,000 IOPS                                 | Up to 100,000 IOPS                |
| <b>Random Write</b>                        | Up to 2,500 IOPS      | Up to 15,000 IOPS<br>(28% O/P: up to 35,000 IOPS) | Up to 23,000 IOPS                 |
| <b>Random Terabytes Written (TBW)</b>      | Up to 320 TBW         | Up to 3,860 TBW<br>Up to 2 WPD                    | Up to 10,200 TBW<br>Up to 10 WPD* |
| <b>Sequential Read</b>                     | Up to 520 MB/s        | Up to 500 MB/s                                    | Up to 900 MB/s                    |
| <b>Sequential Writes</b>                   | Up to 330 MB/s        | Up to 370 MB/s                                    | Up to 500 MB/s                    |
| <b>Sequential Terabytes Written (TBW)</b>  | Up to 1,280 TBW       | Up to 20,000 TBW<br>Up to 11 WPD                  | Up to 26,500 TBW<br>Up to 18 WPD* |
| <b>Physical Dimensions</b>                 | 100 x 70 x 7mm        | 100 x 70 x 7mm                                    | 100 x 70 x 15mm                   |
| <b>Weight</b>                              | 60g                   | 56g                                               | 169g                              |

\*WPD = Drive Writes Per Day for 5 Years

→ Which SSD is right for you?

For more information, email: [SSD@ssi.samsung.com](mailto:SSD@ssi.samsung.com)

## SOLID STATE DRIVES (SSD)

| Drive Type             | Drive Name | Interface           | Form Factor   | Connector  | Component   | Power-loss Protection | Density | Part Number        | Status |
|------------------------|------------|---------------------|---------------|------------|-------------|-----------------------|---------|--------------------|--------|
| Client PC/<br>Embedded | PM841      | SATA III - 6Gb/s    | mSATA MO-300  | Mini PCI-E | 3-bit MLC   | No                    | 128GB   | MZMTD128HAFV-00000 | EOL    |
|                        |            |                     |               |            |             |                       | 256GB   | MZMTD256HAGM-00000 | EOL    |
|                        |            |                     |               |            |             |                       | 512GB   | MZMTD512HAGL-00000 | EOL    |
|                        | SM841      | SATA III - 6Gb/s    | mSATA MO-300  | Mini PCI-E | 2-bit MLC   | No                    | 128GB   | MZMPD128HAFV-00000 | EOL    |
|                        |            |                     |               |            |             |                       | 256GB   | MZMPD256HAGM-00000 | EOL    |
|                        |            |                     |               |            |             |                       | 512GB   | MZMPD512HAGL-00000 | EOL    |
|                        | XP941      | PCIe - SATAe        | M.2 (22x80mm) | M.2        | 2-bit MLC   | No                    | 128GB   | MZHPU128HCGM-00000 | MP     |
|                        |            |                     |               |            |             |                       | 256GB   | MZHPU256HCGL-00000 | MP     |
|                        |            |                     |               |            |             |                       | 512GB   | MZHPU512HCGL-00000 | MP     |
| Data Center            | PM843      | SATA III - 6Gb/s    | 2.5" 7mmT     | SF-8223    | 3-bit MLC   | No                    | 120GB   | MZ7TD120HAFV-000DA | EOL    |
|                        |            |                     |               |            |             |                       | 240GB   | MZ7TD240HAFV-000DA | EOL    |
|                        |            |                     |               |            |             |                       | 480GB   | MZ7TD480HAGM-000DA | EOL    |
|                        | SM843      | SATA III - 6Gb/s    | 2.5" 7mmT     | SF-8223    | 2-bit MLC   | No                    | 120GB   | MZ7PD120HAFV-000DA | EOL    |
|                        |            |                     |               |            |             |                       | 240GB   | MZ7PD240HAFV-000DA | EOL    |
|                        |            |                     |               |            |             |                       | 480GB   | MZ7PD480HAGM-000DA | EOL    |
|                        | SM843T     | SATA III - 6Gb/s    | 2.5" 7mmT     | SF-8223    | 2-bit MLC   | Yes                   | 120GB   | MZ7WD120HCFV-00003 | MP Q4  |
|                        |            |                     |               |            |             |                       | 240GB   | MZ7WD240HCFV-00003 | MP Q4  |
|                        |            |                     |               |            |             |                       | 480GB   | MZ7WD480HCGM-00003 | MP Q4  |
|                        |            |                     |               |            |             |                       | 960GB   | MZ7WD960HCGP-00003 | MP Q4  |
| Storage Enclosure      | SM1625     | SAS Gen 2.0 - 6Gb/s | 2.5" 15mmT    | SFF-8482   | 2-bit E-MLC | Yes                   | 100GB   | MZ6ER100HAFV-00003 | EOL    |
|                        |            |                     |               |            |             |                       | 200GB   | MZ6ER200HAGM-00003 | EOL    |
|                        |            |                     |               |            |             |                       | 400GB   | MZ6ER400HAGL-00003 | EOL    |
|                        |            |                     |               |            |             |                       | 800GB   | MZ6ER800HAGL-00003 | EOL    |

## BLU-RAY SLIM

| Interface | Speed        | Type | Loading | Lightscribe | Model    |
|-----------|--------------|------|---------|-------------|----------|
| SATA      | BD Writer 6X | Slim | Tray    | X           | SN-506BB |

## BLU-RAY WRITER SLIM EXTERNAL

| Interface | Speed        | Type | Loading | Lightscribe | Model    |
|-----------|--------------|------|---------|-------------|----------|
| USB 2.0   | BD Writer 6X | Slim | Tray    | X           | SE-506BB |

## DVD-W H/H

| Interface | Speed         | Type | Loading | Lightscribe | Model    |
|-----------|---------------|------|---------|-------------|----------|
| SATA      | DVD Write 24X | H/H  | Tray    | X           | SH-224DB |

## DVD-W SLIM

| Interface | Speed        | Type | Loading | Lightscribe | Model    |
|-----------|--------------|------|---------|-------------|----------|
| SATA      | DVD Write 8X | Slim | Tray    | X           | SN-208DB |

## DVD-W SLIM EXTERNAL

| Interface | Speed        | Type       | Loading | Lightscribe | Model    |
|-----------|--------------|------------|---------|-------------|----------|
| USB 2.0   | DVD Write 8X | Ultra Slim | Tray    | X           | SE-218CB |
|           |              | Slim       | Tray    | X           | SE-208DB |

## DID Product Classification

|                               |                                            |                                                     |                                          |
|-------------------------------|--------------------------------------------|-----------------------------------------------------|------------------------------------------|
| <b>E-DID: Exclusive DID</b>   | <b>SUPER NARROW BEZEL</b><br>» Video Wall  | <b>OUTDOOR: HIGH LUMINANCE</b><br>» Up to 1500 nits |                                          |
| <b>P-DID: Performance DID</b> | <b>NARROW</b><br>» Narrow<br>» Black Bezel | <b>WALL-MOUNTED</b><br>» Thin/Light<br>» (Edge LED) | <b>LARGE FORMAT DISPLAY</b><br>» 70"/82" |
| <b>B-DID: Basic DID</b>       | <b>LANDSCAPE/PORTRAIT CONVERTIBLE</b>      | <b>ANIT-GLARE/ ANTI-REFLECTIVE</b>                  |                                          |

### Why DID Instead of TV?

|                        | Commercial (DID)                                                                                                                                                                       | Consumer (TV)                                                                                             |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <b>WARRANTY</b>        | 18 months to 2 years                                                                                                                                                                   | 90 days to 1 year                                                                                         |
| <b>RELIABILITY</b>     | Public environments<br>20 hours + daily duty cycle<br>Variety of temperatures & location                                                                                               | Designed for in-home use in controlled environment<br>6-8 hours + daily duty cycle<br>In-home living room |
| <b>PICTURE QUALITY</b> | Designed to resist image retention<br>LCD backlight covers a wider color spectrum necessary for PC source integration giving better picture quality<br>AGAR coating for public viewing | 120Hz /240Hz for full-motion video<br>Designed for TV signals                                             |
| <b>LOCATION</b>        | Can be oriented in either portrait or landscape mode                                                                                                                                   | Can only be oriented in landscape mode                                                                    |

## Product Segmentation

HEAVY USE

↑

↓

LIGHT USE

E-DID: Exclusive

Includes all features of P-DID *plus*:

» Specialty: SNB, High Brightness

» Robust Design

P-DID: Performance

Includes all features of B-DID *plus*:

» Narrow & Black Bezel

» Typ. Brightness: 700 (cd/m2)

B-DID: Basic

» Landscape/Portrait

» High Reliability

» Pol. (Haze 44%)

» Long Lifetime: More than 2 Years

Professional

• Control Room

• Simulation

Outdoor Events

• Scoreboard

• Sports Broadcasting

Billboard

• Billboard

Entertainment

• Casino

• Theatre

• Poster

• Menu

Transportation

• Airport

• Train/Bus Station

Communication

• Conference Room

Rental

• Rental

• Staging

Commercial

• Kiosk

• Mart Board

Education

• e-Board

### Product Segmentation

| TYPE  | ABBR        | WARRANTY  | BEZEL                   | SUGGESTED RUN TIME | BRIGHTNESS       | USAGE  | APPLICATIONS         | PRICING                     |
|-------|-------------|-----------|-------------------------|--------------------|------------------|--------|----------------------|-----------------------------|
| E-DID | Exclusive   | 2 years   | Narrow and Super Narrow | 20 hours +         | 450 to 1500 nits | Heavy  | Outdoor, Video Walls | High-value commercial range |
| P-DID | Performance | 2 years   | Narrow                  | 20 hours +         | 600/700 nits     | Medium | Semi-Outdoor         | Mid-price range             |
| B-DID | Basic       | 18 months | Normal                  | 12 hours           | 450 nits         | Light  | Indoor, e-Board      | High-value commercial range |

## SAMSUNG DIGITAL INFORMATION DISPLAY (DID) PANEL LINEUP

| Type        | Current Model | Size  | Model resolution | Bezel          | Backlight          | Brightness (typical) | Contrast Ratio | Response Time | Frequency | MP*        | Comment                            | High TNI 85°C |
|-------------|---------------|-------|------------------|----------------|--------------------|----------------------|----------------|---------------|-----------|------------|------------------------------------|---------------|
| E-DID       | LT1216XM01    | 21.6" | 960x960          | Super narrow   | D-LED              | 450 nits             | 4,000:1        | 8ms           | 60Hz      | Now        | Square panel                       | 85°C          |
|             | LT1460HN03    | 46"   | FHD              | Narrow + Black | CCFL               | 1500 nits            | 3,000:1        | 8ms           | 60Hz      | Ltd Avail. | High Bright, Hi Temp LC, 1/4λ Pol. | 85°C          |
|             | LT1460HN01    | 46"   | FHD              | Super narrow   | D-LED              | 700 nits             | 3,000:1        | 8ms           | 60Hz      | Now        | 5.9mm Active to Active, LED        | 85°C          |
|             | LT1460HN07    | 46"   | FHD              | Super narrow   | D-LED              | 450 nits             | 3,000:1        | 8ms           | 60Hz      | Ltd Avail. | 5.9mm Active to Active, LED        | 85°C          |
|             | LT1460HN09    | 46"   | FHD              | Super narrow   | D-LED              | 500 nits             | 3,000:1        | 8ms           | 60Hz      | New 10/13  | 5.9mm Active to Active, LED        | 85°C          |
|             | LT1460AA05    | 46"   | HD               | Super narrow   | CCFL               | 450 nits             | 4,000:1        | 8ms           | 60Hz      | EOL        | 7.3mm Active to Active             | 85°C          |
|             | LT1460AN01    | 46"   | HD               | Super narrow   | CCFL               | 450 nits             | 4,000:1        | 8ms           | 60Hz      | NEW        | 7.3mm Active to Active, TiCu       | 85°C          |
|             | LT1460HN10    | 16"   | FHD              | Narrow         | D-LED              | 2,500 nits           | 3,000:1        | 8Ms           | 60Hz      | New 11/13  | High Bright, Hi Temp LC, 1/4λ Pol. | 110°C         |
|             | LT1550HN01    | 55"   | FHD              | Super narrow   | D-LED              | 700 nits             | 3,000:1        | 8ms           | 60Hz      | Now        | 5.9mm Active to Active, LED        | 85°C          |
|             | LT1550HN05    | 55"   | FHD              | Super narrow   | D-LED              | 450 nits             | 3,000:1        | 8ms           | 60Hz      | Ltd Avail. | 5.9mm Active to Active, LED        | 85°C          |
| P-DID       | LT1550HN08    | 55"   | FHD              | Super narrow   | D-LED              | 500 nits             | 3,000:1        | 8ms           | 60Hz      | New 10/13  | 5.7mm Active to Active, LED        | 85°C          |
|             | LT1400HA08    | 40"   | FHD              | Narrow + Black | CCFL               | 700 nits             | 3,000:1        | 8ms           | 60Hz      | Ltd Avail. |                                    | 85°C          |
|             | LT1400HA10    | 40"   | FHD              | Narrow         | E-LED              | 700 nits             | 3,000:1        | 8ms           | 60Hz      | Now        | LED                                | 85°C          |
|             | LT1460HN05    | 46"   | FHD              | Narrow + Black | CCFL               | 700 nits             | 3,500:1        | 8ms           | 60Hz      | Ltd Avail. |                                    | 85°C          |
|             | LT1460HN08    | 46"   | FHD              | Narrow         | E-LED              | 700 nits             | 4,000:1        | 8ms           | 60Hz      | Now        | LED                                | 85°C          |
|             | LT1550HN03    | 55"   | FHD              | Narrow         | CCFL               | 700 nits             | 4,000:1        | 8ms           | 60Hz      | Ltd Avail. |                                    | 85°C          |
|             | LT1550HN06    | 55"   | FHD              | Narrow         | E-LED              | 700 nits             | 4,000:1        | 8ms           | 60Hz      | Now        |                                    | 85°C          |
|             | LT1550HN07    | 55"   | FHD              | Narrow         | E-LED              | 450 nits             | 4,000:1        | 8ms           | 60Hz      | New 7/13   |                                    | 85°C          |
|             | LT1700HD01    | 70"   | FHD              | Normal         | CCFL               | 600 nits             | 2,000:1        | 8ms           | 60Hz      | EOL        |                                    |               |
| B-DID       | LT1820HT-L01  | 82"   | FHD              | Normal         | CCFL               | 600 nits             | 2,000:1        | 8ms           | 60Hz      | EOL        |                                    |               |
|             | LT1460HN04-N  | 46"   | FHD              | Normal         | CCFL               | 450 nits             | 3,000:1        | 8ms           | 60Hz      | EOL        |                                    | 85°C          |
|             | LT1550HN02    | 55"   | FHD              | Normal         | CCFL               | 450 nits             | 3,500:1        | 8ms           | 60Hz      | Now        |                                    | 85°C          |
|             | LT1700HA02    | 70"   | FHD              | Normal         | E-LED              | 400 nits             | 4,000:1        | 8ms           | 60Hz      | Now        | E-Board; Landscape mode only       | 85°C          |
|             | LT1820HD03    | 82"   | FHD              | Normal         | CCFL               | 450 nits             | 2,000:1        | 8ms           | 60Hz      | EOL        | E-Board; Landscape mode only       |               |
| Transparent | LT1820HA01    | 82"   | FHD              | Normal         | E-LED              | 450 nits             | 3,000:1        | 8ms           | 60Hz      | New 8/13   | E-Board; Landscape mode only       | 85°C          |
|             | LT1460AP01    | 46"   | HD               | Narrow         | Transparent/No BLU |                      | 4,500:1        | 8ms           | 60Hz      | Now        |                                    |               |
|             | LT1220MT02    | 46"   | WSXGA+           | Narrow         | Transparent/No BLU |                      | 5,000:1        | 5ms           | 60Hz      | EOL        | LVDS Input                         |               |

## TABLETS

| Size           | PN         | Mode | Resolution | H(RGB) | V    | Aspect Ratio | PPI | Brightness (nits) | MP  |
|----------------|------------|------|------------|--------|------|--------------|-----|-------------------|-----|
| 7"             | LTN070AL01 | PLS  | WXGA       | 1280   | 800  | 16:10        | 216 | 400               | EOL |
|                | LTL070NL01 | PLS  | WSVGA      | 1024   | 600  | 16:09        | 170 | 400               | Now |
| 8.0" Open Cell | LTL080AL01 | PLS  | WXGA       | 1280   | 800  | 16:09        | 189 | N/A               | Now |
| 10.1"          | LTL101AL06 | PLS  | WXGA       | 1280   | 800  | 16:10        | 149 | 400               | Now |
|                | LTL101DL03 | PLS  | WQXGA      | 2560   | 1600 | 16:10        | 300 | 370               | Now |

## MONITORS

| Size | PN         | Mode | Resolution | H(RGB) | V    | Aspect Ratio | PPI | Brightness (nits) | MP         |
|------|------------|------|------------|--------|------|--------------|-----|-------------------|------------|
| 23"  | LTM230HT10 | TN   | FHD        | 1920   | 1080 | 16:09        | 96  | 300               | Ltd Avail. |
|      | LTM230HT11 | TN   | FHD        | 1920   | 1080 | 16:09        | 96  | 300               | New        |
|      | LTM230HL01 | PLS  | FHD        | 1920   | 1080 | 16:09        | 96  | 300               | Now        |
| 27"  | LTM270HT03 | TN   | FHD        | 1920   | 1080 | 16:09        | 82  | 300               | Now        |
|      | LTM270DL02 | PLS  | QHD        | 2560   | 1440 | 16:09        | 109 | 300               | Now        |
|      | LTM270HL02 | PLS  | FHD        | 1920   | 1080 | 16:09        | 82  | 350               | Now        |



# Contacts

Feel free to contact your local distributor or sales representative with any Samsung sales inquiries.

## Representatives

| NAME                                                                               | PRODUCTS              | ADDRESS                                                                                          | MAIN PHONE                     | FAX                          |
|------------------------------------------------------------------------------------|-----------------------|--------------------------------------------------------------------------------------------------|--------------------------------|------------------------------|
| <b>Adelsa</b>                                                                      | Memory<br>SLSI<br>LCD | Hacienda Corralejo #80<br>Bosque de Echegaray<br>Naucalpan, Mexico 53310                         | 52-555-560-5002                |                              |
|                                                                                    |                       | Guadalajara office                                                                               |                                |                              |
|                                                                                    |                       | Monterrey office                                                                                 |                                |                              |
|                                                                                    |                       | Cd. Juarez office                                                                                |                                |                              |
| <b>ATMI Sales</b><br><a href="http://www.atmisales.com">www.atmisales.com</a>      | Memory<br>SLSI        | <b>OREGON</b><br>4900 S.W. Griffith Drive<br>Suite 253<br>Beaverton, OR 97005                    | 1-800-898-2446<br>503-643-8307 | 503-643-4364<br>503-643-4364 |
|                                                                                    |                       | <b>WASHINGTON</b><br>8581 154th Ave. NE<br>Redmond WA 98052                                      | 425-869-7636                   | 425-869-9841                 |
| <b>Bear VAI Technology</b><br><a href="http://www.bearvai.com">www.bearvai.com</a> | Memory<br>SLSI<br>LCD | <b>MAIN OFFICE - BRECKSVILLE, OHIO</b><br>6910 Treeline Drive<br>Unit H<br>Brecksville, OH 44141 | 440-526-1991                   | 440-526-5426                 |
|                                                                                    |                       | <b>MAIN OFFICE - INDIANA</b><br>11451 Overlook Drive<br>Fishers, IN 46037                        | 440-832-7637                   | 317-845-8650                 |
|                                                                                    |                       | <b>SOUTHERN OHIO OFFICES</b><br>2676 Longwood Dr.<br>Beavercreek, Ohio 45431                     | 440-526-1991                   | 440-526-5426                 |
|                                                                                    |                       | 3130 Brookview Dr.<br>Galena, Ohio 43021                                                         | 440-526-1991                   | 440-526-5426                 |
|                                                                                    |                       | <b>PITTSBURGH OFFICE</b><br>1975 Menold Dr.<br>Allison Park, PA 15101                            | 440-526-1991                   | 412-364-8776                 |
|                                                                                    |                       | <b>INDIANA/KENTUCKY OFFICES</b><br>11451 Overlook Drive<br>Fishers, IN 46038                     | 440-526-1991                   | 317-845-8650                 |
|                                                                                    |                       | <b>MICHIGAN OFFICES</b><br>5506 Alpine Ridge<br>Stevensville, MI 49127                           | 440-526-1991                   | 440-526-5426                 |
|                                                                                    |                       | 17426 Willow Ridge<br>Northville, MI 48168                                                       |                                |                              |
|                                                                                    |                       | 1844 Clover Ridge Drive<br>Howell, MI 48843                                                      |                                |                              |
|                                                                                    |                       | 600 Broadway Ave NW #617<br>Grand Rapids, MI 49504                                               |                                |                              |
|                                                                                    |                       | 3120 Edgewood Park Dr.<br>Commerce Twp, MI 48382                                                 |                                |                              |
| <b>Core Sales, Inc</b><br><a href="http://www.coresales.com">www.coresales.com</a> | Memory<br>SLSI<br>LCD | 901 Warrenville Road<br>Suite 211<br>Lisle, IL 60532                                             | 847-843-8888                   |                              |



## Representatives

| NAME                                                                                                 | PRODUCTS              | ADDRESS                                                                                                  | MAIN PHONE     | FAX                                          |
|------------------------------------------------------------------------------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------|----------------|----------------------------------------------|
| <b>Crestone Technology Group</b><br><a href="http://www.crestonegroup.com">www.crestonegroup.com</a> | Memory<br>SLSI<br>LCD | <b>COLORADO</b><br>7108 S. Alton Way<br>Building L<br>Centennial, CO 80112                               | 303-280-7202   | 720-482-2220                                 |
|                                                                                                      |                       | <b>UTAH*</b><br><i>*all employees are home office based</i><br>841 E. Rosefield Lane<br>Draper, UT 84020 |                |                                              |
|                                                                                                      |                       | 1578 West Trailside Road<br>Farmington, UT 84025                                                         |                |                                              |
| <b>CUSTOMER 1st</b><br><a href="http://www.customer1st.com">www.customer1st.com</a>                  | Memory<br>SLSI<br>LCD | <b>MINNESOTA</b><br>2950 Metro Drive, Suite 101<br>Bloomington, MN 55425                                 | 952 851 7909   | 952 851 7907                                 |
|                                                                                                      |                       | <b>KANSAS</b><br>2111 E. Crossroad Lane, Suite 202<br>Olathe, KS 66062                                   |                |                                              |
|                                                                                                      |                       | <b>IOWA</b><br>342 Eastland Drive SE<br>Cedar Rapids, IA 52403                                           |                |                                              |
| <b>Digit Tech Sales, Inc.</b><br><a href="http://www.digit-tech.com">www.digit-tech.com</a>          | Memory<br>SLSI<br>LCD | P.O. BOX 1945<br>14 Calle Carro Ste 1<br>San German PR 00683-4089                                        | 787-892-4260   | 787-892-3366                                 |
|                                                                                                      |                       | Rua Dr. Renato Paes de Barros, 750-Cj.52<br>Itaim Bibi<br>Sao Paulo, SP, Brazil                          | 5511-3165-2218 | 5511-3165-2216                               |
|                                                                                                      |                       | Manaus, Brazil                                                                                           |                |                                              |
|                                                                                                      |                       | Miami, FL                                                                                                | 787-892-4260   | 787-892-3366                                 |
| <b>InTELaTECH</b><br><a href="http://www.intelatech.com">www.intelatech.com</a>                      | Memory<br>SLSI        | <b>ONTARIO-CANADA</b><br>5225 Orbitor Drive, Suite 2<br>Mississauga, ONT L4W 4Y8                         | 905-629-0082   | 905-624-6909<br>905-629-1795<br>905-629-8910 |
|                                                                                                      |                       | 21 Concourse Gate, Suite 12<br>Ottawa, ONT K2E 7S4                                                       | 905-629-0082   | 613-221-9160                                 |
|                                                                                                      |                       | <b>ALBERTA-CANADA</b><br>14939 Mt. McKenzie Drive SE<br>Calgary, Alberta T2Z 2M6                         | 905-629-0082   | 403-686-6926                                 |
|                                                                                                      |                       | <b>QUEBEC-CANADA</b><br>620 St. Jean Boulevard, Suite 202<br>Pointe Claire, Quebec H9R 3K2               | 905-629-0082   | 905-629-0082                                 |
|                                                                                                      |                       | <b>BRITISH COLUMBIA-CANADA</b><br>5811 Cooney Road<br>Suit 305, South Tower<br>Vancouver, BC V5X 3M1     | 905-629-0082   | 905-629-1795                                 |
| <b>I-Squared Incorporated</b><br><a href="http://www.isquared.com">www.isquared.com</a>              | Memory<br>SLSI<br>LCD | 2635 N. 1st Street, Suite 128<br>San Jose, CA 95134                                                      | 408-988-3400   | 408-988-2079                                 |
|                                                                                                      |                       | 1250 B Street<br>Petaluma, CA 94952                                                                      |                |                                              |
| <b>Neptune Electronics (necco)</b><br><a href="http://www.neccolect.com">www.neccolect.com</a>       | Memory<br>SLSI<br>LCD | 11 Oval Drive, Suite 169<br>Islandia, NY 11749                                                           | 631-234-2525   | 631-234-2707                                 |
| <b>New Elpis, Inc.</b><br><a href="http://www.newelpis.com">www.newelpis.com</a>                     | LCD                   | 2550 Matheson Boulevard E. Unit 129<br>Mississauga, ONT Canada L4W 4Z1                                   | 905-275-3516   | 905-275-4109                                 |
| <b>New Tech Solutions</b><br><a href="http://www.ntsca.com">www.ntsca.com</a>                        | Memory<br>SLSI<br>LCD | 26 Ray Avenue<br>Burlington, MA 01803                                                                    | 781-229-8888   | 781-229-1614                                 |

## Representatives

| NAME                                                                                         | PRODUCTS                      | ADDRESS                                                                                   | MAIN PHONE                   | FAX                       |
|----------------------------------------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------------|------------------------------|---------------------------|
| <b>Rep One Associates, Inc.</b><br><a href="http://www.repone.com">www.repone.com</a>        | Memory<br>SLSI<br>LCD         | <b>ALABAMA</b><br>303 Williams Avenue, Suite 1011<br>Huntsville, AL 35801                 | 256-539-7371                 | 256-533-4509              |
|                                                                                              |                               | <b>GEORGIA</b><br>3000 Langford Road, Building 300<br>Norcross, GA 30071                  | 770-209-9242<br>678-591-6753 | 770-209-9245              |
|                                                                                              |                               | <b>NORTH CAROLINA</b><br>5540 Centerview Drive, Suite 200<br>Raleigh, NC 27606            | 704-846-5744                 | 919-424-3866              |
|                                                                                              |                               | 10800 Sikes Place, Suite 300<br>Charlotte, NC 28277                                       | 704-846-5744                 | 704-846-5925              |
|                                                                                              |                               | <b>FLORIDA</b><br>128 Ledbury Drive<br>Longwood, FL 32779                                 |                              |                           |
| <b>West Associates</b><br><a href="http://www.westassociates.com">www.westassociates.com</a> | Memory<br>SLSI<br>LCD         | <b>AUSTIN / SAN ANTONIO</b><br>4100 Duval Road<br>Building 1, Ste 102<br>Austin, TX 78759 | 512-343-1199                 | 512-343-1922              |
|                                                                                              |                               | <b>DALLAS / OKLAHOMA / ARKANSAS</b><br>2745 Dallas Parkway, Suite 460<br>Plano, TX 75093  | 972-680-2800                 | 972-699-0330              |
|                                                                                              |                               | <b>HOUSTON / VALLEY / LOUISIANA</b><br>1117 Cheshire Lane<br>Houston, TX 77018            | 512-343-1199                 | 512-343-1922              |
| <b>Tech Coast</b><br><a href="http://tc-sales.com">http://tc-sales.com</a>                   | Memory<br>System Logic<br>LCD | 23121 Verdugo Drive, Suite 101<br>Laguna Hills, CA 92653                                  | 949-305-6869                 | Email: sales@tc-sales.com |

## Distributors

| NAME                                                                                                  | ADDRESS                                                                   | MAIN PHONE                   | FAX          | OTHER                                                                                                                                                              |
|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|------------------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Edge Electronics, Inc.</b><br><a href="http://www.edgeelectronics.com">www.edgeelectronics.com</a> | Headquarters<br>75 Orville Drive, Unit 2<br>Bohemia, NY 11716             | 800-647-EDGE (3343)          | 631-471-3405 | Email: edge@edgeelectronics.com                                                                                                                                    |
| <b>Avnet, Inc.</b><br><a href="http://www.avnet.com">www.avnet.com</a>                                | Headquarters<br>2211 South 47th Street<br>Phoenix, AZ 85034               | 800-409-1483                 |              | For sales inquiries:<br>800-332-8638<br><a href="http://www.avnetexpress.com">www.avnetexpress.com</a>                                                             |
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| <b>Arrow Electronics, Inc.</b><br><a href="http://www.arrow.com">www.arrow.com</a>                    | Corporate Headquarters<br>7459 S. Lima Street<br>Englewood, CO 80112-5816 | 303-824-4000                 |              | For sales inquiries:<br><a href="http://www.arrownac.com">www.arrownac.com</a><br><a href="mailto:onlinesales@arrow.com">onlinesales@arrow.com</a><br>800-833-3557 |

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