

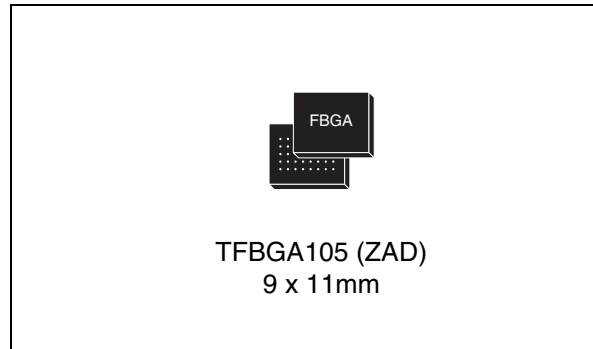
256 or 512Mbit (x16, Multiple Bank, Multi-Level, Burst) Flash memory
128 Mbit Low Power SDRAM, 1.8V supply, Multi-Chip Package

Feature summary

- Multi-Chip Package
 - 1 die of 256 (16Mb x 16) or 512 Mbit (32Mb x 16, Multiple Bank, Multi-Level, Burst) Flash memory
 - 1 die of 128 Mbit (4 Banks of 2Mb x16) Low Power Synchronous Dynamic RAM
- Supply voltage
 - $V_{DDF} = V_{DDS} = V_{DDQ} = 1.7$ to $1.95V$
 - $V_{PPF} = 9V$ for fast program
- Electronic signature
 - Manufacturer Code: 20h
 - 256 Mbit Device Code: 8818
 - 512 Mbit Device Code: 8819
- Package
 - ECOPACK® (RoHS compliant)

Flash memory

- Synchronous / Asynchronous Read
 - Synchronous Burst Read mode: 108MHz, 66MHz
 - Asynchronous Page Read mode
 - Random Access: 96ns
- Programming time
 - 4.2µs typical Word program time using Buffer Enhanced Factory Program command
- Memory organization
 - Multiple Bank memory array: 32 Mbit Banks (256Mb devices); 64 Mbit Banks (512Mb devices)
 - Four Extended Flash Array (EFA) Blocks of 64 Kbits
- Dual operations
 - program/erase in one Bank while read in others
 - No delay between read and write operations



- 100,000 program/erase cycles per block
- Security
 - 64-bit unique device number
 - 2112-bit user programmable OTP Cells
- Block locking
 - All Blocks locked at power-up
 - Any combination of Blocks can be locked with zero latency
 - $\overline{WP_F}$ for Block Lock-Down
 - Absolute Write Protection with $V_{PPF} = V_{SS}$
- Common Flash Interface (CFI)

LPSPDRAM

- 128 Mbit Synchronous Dynamic RAM
 - Organized as 4 Banks of 2 MWords, each 16 bits wide
- Synchronous Burst Read and Write
 - Fixed burst lengths: 1, 2, 4, 8 Words or Full Page
 - Burst Types: Sequential and Interleaved
 - Maximum Clock frequency: 104MHz
- Automatic and controlled Precharge
- Low power features:
 - Partial Array Self Refresh (PASR)
 - Automatic Temperature Compensated Self Refresh (TCSR)
 - Driver Strength (DS)
 - Deep Power-Down Mode
- Auto Refresh and Self Refresh

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1 Summary description

The M39P0R8070E2 and M39P0R9070E2 combine two memory devices in a Multi-Chip Package:

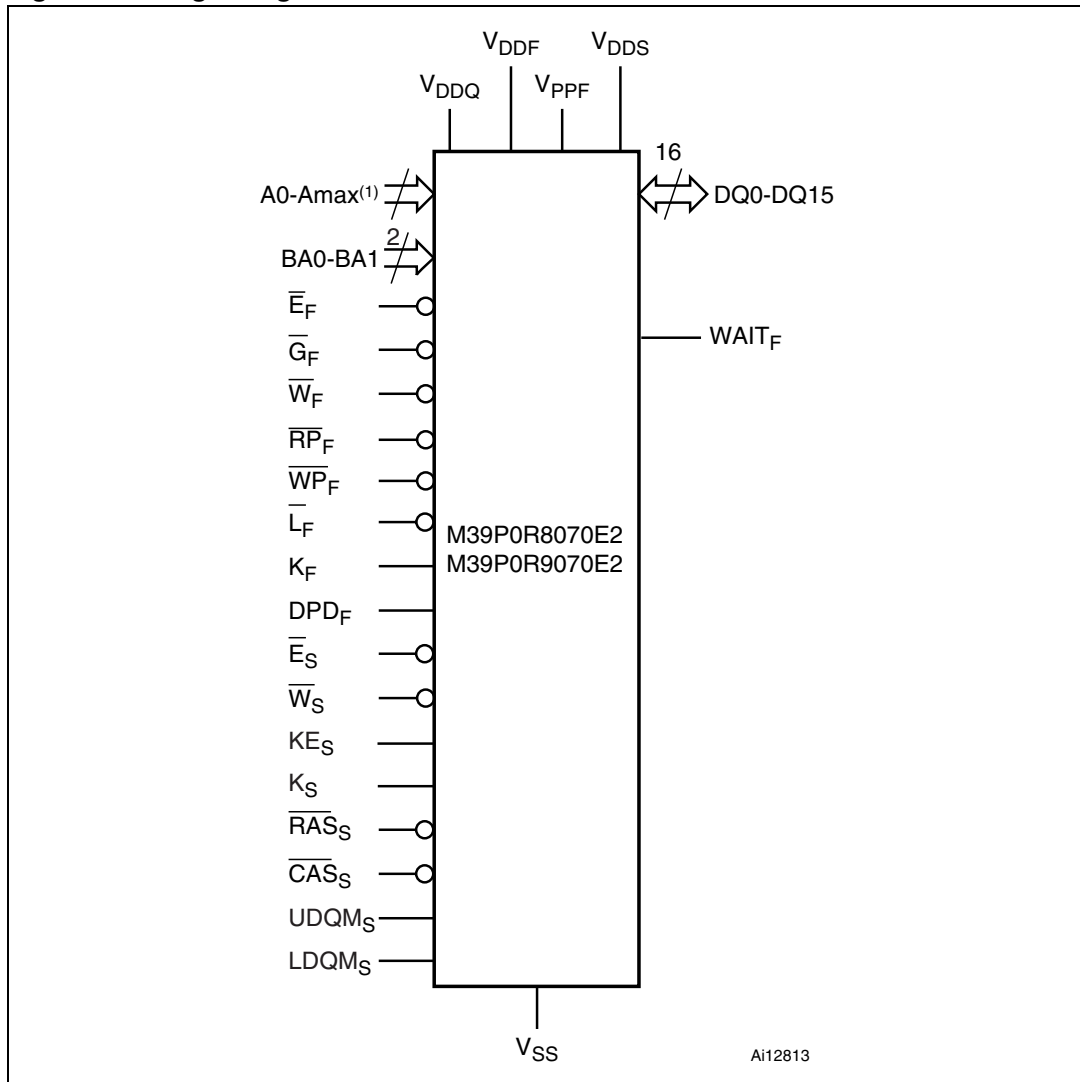
- 256-Mbit (M58PR256J) or 512-Mbit (M58PR512J) Multiple Bank Flash memory
- 128-Mbit Low Power Synchronous DRAM (the M65KA128AE)

The purpose of this document is to describe how the two memory components operate with respect to each other. It should be read in conjunction with the M58PRxxxJ and M65KA128AE datasheets, where all specifications required to operate the Flash memory and LPSDRAM components are fully detailed. These datasheets are available from your local Numonyx distributor.

Recommended operating conditions do not allow more than one memory to be active at the same time.

The memory is offered in a Stacked TFBGA105 package. It is supplied with all the bits erased (set to '1').

Figure 1. Logic diagram



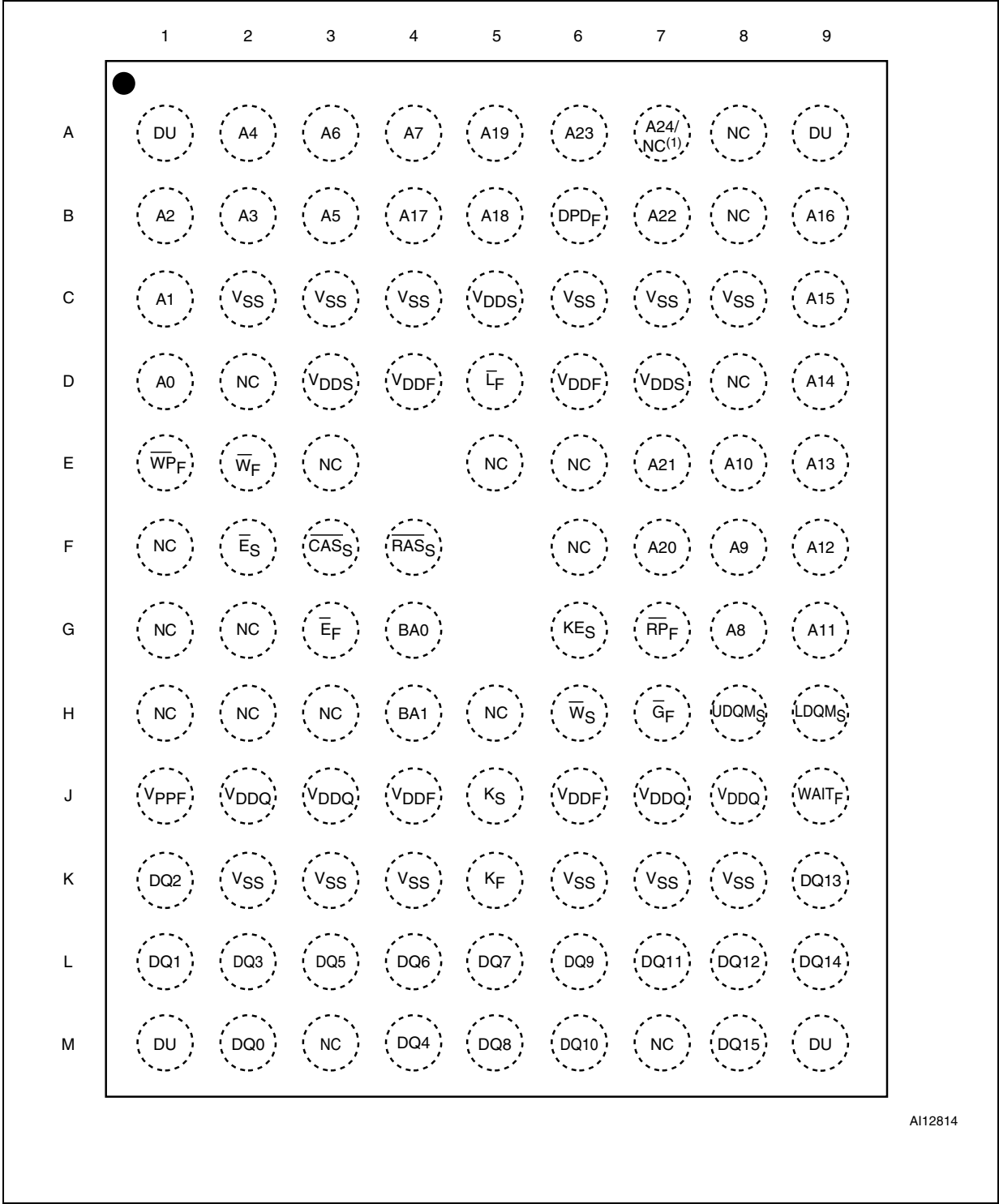
1. Amax is A23 in the M39P0R8070E2 and A24 in the M39P0R9070E2.

Table 1. Signal names

A0-Amax ⁽¹⁾	Address Inputs
DQ0-DQ15	Common Data Input/Output
V _{DDQ}	Common Flash and LPSPDRAM Power Supply for I/O Buffers
V _{PPF}	Flash Memory Optional Supply Voltage for Fast Program & Erase
V _{DDF}	Flash Memory Power Supply
V _{DDS}	LPSPDRAM Power Supply
V _{SS}	Ground
NC	Not Connected Internally
DU	Do Not Use as Internally Connected
Flash Memory	
$\overline{E}_F$	Chip Enable input
$\overline{G}_F$	Output Enable Input
$\overline{W}_F$	Write Enable input
$\overline{RP}_F$	Reset input
$\overline{WP}_F$	Write Protect input
$\overline{L}_F$	Latch Enable input
K _F	Burst Clock
WAIT _F	Wait Output
DPD _F	Deep Power-Down
Low Power SDRAM	
$\overline{E}_S$	Chip Enable Input
$\overline{W}_S$	Write Enable input
K _S	LPSPDRAM Clock input
KE _S	LPSPDRAM Clock Enable input
$\overline{CAS}_S$	Column Address Strobe Input
$\overline{RAS}_S$	Row Address Strobe Input
BA0, BA1	Bank Select Inputs
UDQM _S	Upper Data Input/Output Mask
LDQM _S	Lower Data Input/Output Mask

1. A12-A23 (in the M39P0R8070E2) or A12-A24 (in the M39P0R9070E2) are Address Inputs for the Flash memory component only.

Figure 2. TFBGA connections (top view through package)



1. Ball A7 is NC in the M39P0R8070E2 and it is A24 in the M39P0R9070E2.

2 Signal descriptions

See [Figure 1: Logic diagram](#) and [Table 1: Signal names](#), for a brief overview of the signals connect-ed to this device.

2.1 Address inputs (A0-Amax)

Amax is equal to A23 in the M39P0R8070E2 and, to A24 in the M39P0R9070E2.

A0-A11 are common to the Flash memory and LPSPDRAM components. A12-AMax are Address Inputs for the Flash memory component only. In the Flash memory, the Address Inputs select the cells in the memory array to access during Bus Read operations. During Bus Write operations they control the commands sent to the Command Interface of the Program/Erase Controller. In the LPSPDRAM, the A0-A11 Address Inputs are used to select the row or column to be made active. If a row is selected, all A0-A11 Address Inputs are used. If a column is selected, only the nine least significant Address Inputs, A0-A8, are used. In this latter case, A10 determines whether Auto Precharge is used. If A10 is High (set to '1') during Read or Write, the Read or Write operation includes an Auto Precharge cycle. If A10 is Low (set to '0') during Read or Write, the Read or Write cycle does not include an Auto Precharge cycle.

2.2 LPSPDRAM Bank Select Address Inputs (BA0-BA1)

The BA0 and BA1 Bank Select Address Inputs are used by the LPSPDRAM to select the bank to be made active. The LPSPDRAM must be enabled, the Row Address Strobe, RASs, must be Low, V_{IL} , the Column Address Strobe, CASs, and W must be High, V_{IH} , when selecting the addresses. The address inputs are latched on the rising edge of the clock signal, K_S .

2.3 Data Inputs/Outputs (DQ0-DQ15)

In the Flash memory, the Data I/O output the data stored at the selected address during a Bus Read operation or input a command or the data to be programmed during a Bus Write operation. In the LPSPDRAM, the Data Inputs/Outputs are common to all memory components. They output the data stored at the selected address during a Read operation, or are used to input the data during a write operation.

2.4 Flash memory Chip Enable Input ($\overline{E_F}$)

The Chip Enable input activates the memory control logic, input buffers, decoders and sense amplifiers. When Chip Enable is at V_{IL} and Reset is at V_{IH} the device is in active mode. When Chip Enable is at V_{IH} the memory is deselected, the outputs are high impedance and the power consumption is reduced to the standby level. It is not allowed to have E_F and E_S all at V_{IL} at the same time, only one memory component should be enabled at a time.

2.5 Flash memory Output Enable ($\overline{G}_F$)

The Output Enable input controls data outputs during the Bus Read operation of the memory.

2.6 Flash memory Write Enable ($\overline{W}_F$)

The Write Enable input controls the Bus Write operation of the Flash memory's Command Interface. The data and address inputs are latched on the rising edge of Chip Enable or Write Enable whichever occurs first.

2.7 Flash memory Write Protect input ($\overline{WP}_F$)

Write Protect is an input that gives an additional hardware protection for each block. When Write Protect is at V_{IL} , the Lock-Down is enabled and the protection status of the Locked-Down blocks cannot be changed. When Write Protect is at V_{IH} , the Lock-Down is disabled and the Locked-Down blocks can be locked or unlocked. (See M58PR512J datasheet for details).

2.8 Flash memory Reset ($\overline{RP}_F$)

The Reset input provides a hardware reset of the memory. When

Reset is at V_{IL} , the memory is in reset mode: the outputs are high impedance and the current consumption is reduced to the Reset Supply Current

I_{DD2} (Refer to the M58PRxxxJ datasheet, for the value of I_{DD2}). After Reset all blocks are in the Locked state and the Configuration Register is reset. When Reset is at V_{IH} , the device is in normal operation. Exiting reset mode the device enters asynchronous read mode, but a negative transition of Chip Enable or Latch Enable is required to ensure valid data outputs. The Reset pin can be interfaced with 3V logic without any additional circuitry. It can be tied to V_{RPH} (refer to M58PRxxxJ datasheet).

2.9 Flash memory Deep Power-Down (DPD_F)

The Deep Power-Down input is used to put the Flash memory in Deep Power-Down mode.

When the Flash memory is in Standby mode and the Enhanced Configuration Register bit ECR15 is set, asserting the Deep Power-Down input will cause the memory to enter the Deep Power-Down mode.

When the device is in the Deep Power-Down mode, the memory cannot be modified and the data is protected.

The polarity of the DPD_F pin is determined by ECR14. The Deep Power-Down input is active Low by default.

2.10 Flash memory Latch Enable ($\overline{L}_F$)

The Latch Enable input latches the address bits on its rising edge. The address latch is transparent when Latch Enable is at V_{IL} and it is inhibited when Latch Enable is at V_{IH} . Latch Enable can be kept Low (also at board level) when the Latch Enable function is not required or supported.

2.11 Flash memory Clock (K_F)

The clock input synchronizes the memory to the microcontroller during synchronous read operations; the address is latched on a Clock edge (rising or falling, according to the configuration settings) when Latch Enable is at V_{IL} . Clock is ignored during asynchronous read and in write operations.

2.12 Flash memory Wait ($WAIT_F$)

Wait is an output signal used during synchronous read to indicate whether the data on the output bus are valid. This output is high impedance when Chip Enable is at V_{IH} , Output Enable is at V_{IH} , or Reset is at V_{IL} . It can be configured to be active during the wait cycle or one data cycle in advance.

2.13 LPSPDRAM Chip Select ($\overline{E}_S$)

The Chip Select input $\overline{E}_S$ activates the LPSPDRAM state machine, address buffers and decoders when driven Low, V_{IL} . When High, V_{IH} , the device is not selected.

2.14 LPSPDRAM Column Address Strobe ($\overline{CAS}_S$)

The Column Address Strobe, $\overline{CAS}_S$, is used in conjunction with Address Inputs A8-A0 and BA1-BA0, to select the starting column location prior to a Read or Write.

2.15 LPSPDRAM Row Address Strobe ($\overline{RAS}_S$)

The Row Address Strobe, $\overline{RAS}_S$, is used in conjunction with Address Inputs A11-A0 and BA1-BA0, to select the starting address location prior to a Read or Write.

2.16 LPSPDRAM Write Enable ($\overline{W}_S$)

The Write Enable input, $\overline{W}_S$, controls writing to the LPSPDRAM.

2.17 LPSPDRAM Clock input (K_S)

The Clock signal, K_S , is used to clock the Read and Write cycles. During normal operation, the Clock Enable pin, KE_S , is High, V_{IH} . The clock signal K_S can be suspended to switch the device to the Self Refresh, Power-Down or Deep Power-Down mode by driving KE_S Low, V_{IL} .

2.18 LPSDRAM Clock Enable (KE_S)

The Clock Enable, KE_S , pin is used to control the synchronizing of the signals with Clock signal K_S . If KE_S is High, V_{IH} , the next Clock rising edge is valid. When KE_S is Low, V_{IL} , the signals are no longer clocked and data Read and Write cycles are extended. KE_S is also involved in switching the device to the Self-Refresh, Power-Down and Deep Power-Down modes.

2.19 LPSDRAM Lower/Upper Data Input/Output Mask ($LDQM_S/UDQM_S$)

Lower Data Input/Output Mask and Upper Data Input/Output Mask pins are input signals used to mask the Read or Write data. The DQM latency is two clock cycles for read operations and there is no latency for write operations.

2.20 Flash memory V_{DDF} supply voltage

V_{DDF} provides the power supply to the internal core of the Flash memory component. It is the main power supply for all operations (Read, Program and Erase).

2.21 LPSDRAM V_{DDS} supply voltage

V_{DDS} provides the power supply to the internal core of the LPSDRAM component. It is the main power supply for all operations (Read and Write).

2.22 V_{DDQ} supply voltage

V_{DDQ} is common to the Flash memory and LPSDRAM memory components. It provides the power supply to the I/O pins and enables all Outputs to be powered independently of V_{DDF} for the Flash memory, or V_{DDS} for the LPSDRAM. V_{DDQ} can be tied to V_{DDF} or V_{DDS} , or can use a separate supply.

2.23 Flash memory V_{PPF} Program supply voltage

V_{PPF} is both a control input and a power supply pin. The two functions are selected by the voltage range applied to the pin. If V_{PP} is kept in a low voltage range (0V to V_{DDQ}) V_{PP} is seen as a control input. In this case a voltage lower than V_{PPLK} gives an absolute protection against program or erase, while $V_{PP} > V_{PP1}$ enables these functions (see M58PRxxxJ datasheet for the relevant values). V_{PP} is only sampled at the beginning of a program or erase; a change in its value after the operation has started does not have any effect and program or erase operations continue. If V_{PP} is in the range of V_{PPH} it acts as a power supply pin. In this condition V_{PP} must be stable until the Program/Erase algorithm is completed.

2.24 V_{SS} ground

V_{SS} ground is common to the LPSPDRAM and Flash memory components. It is the reference for the core supply. It must be connected to the system ground.

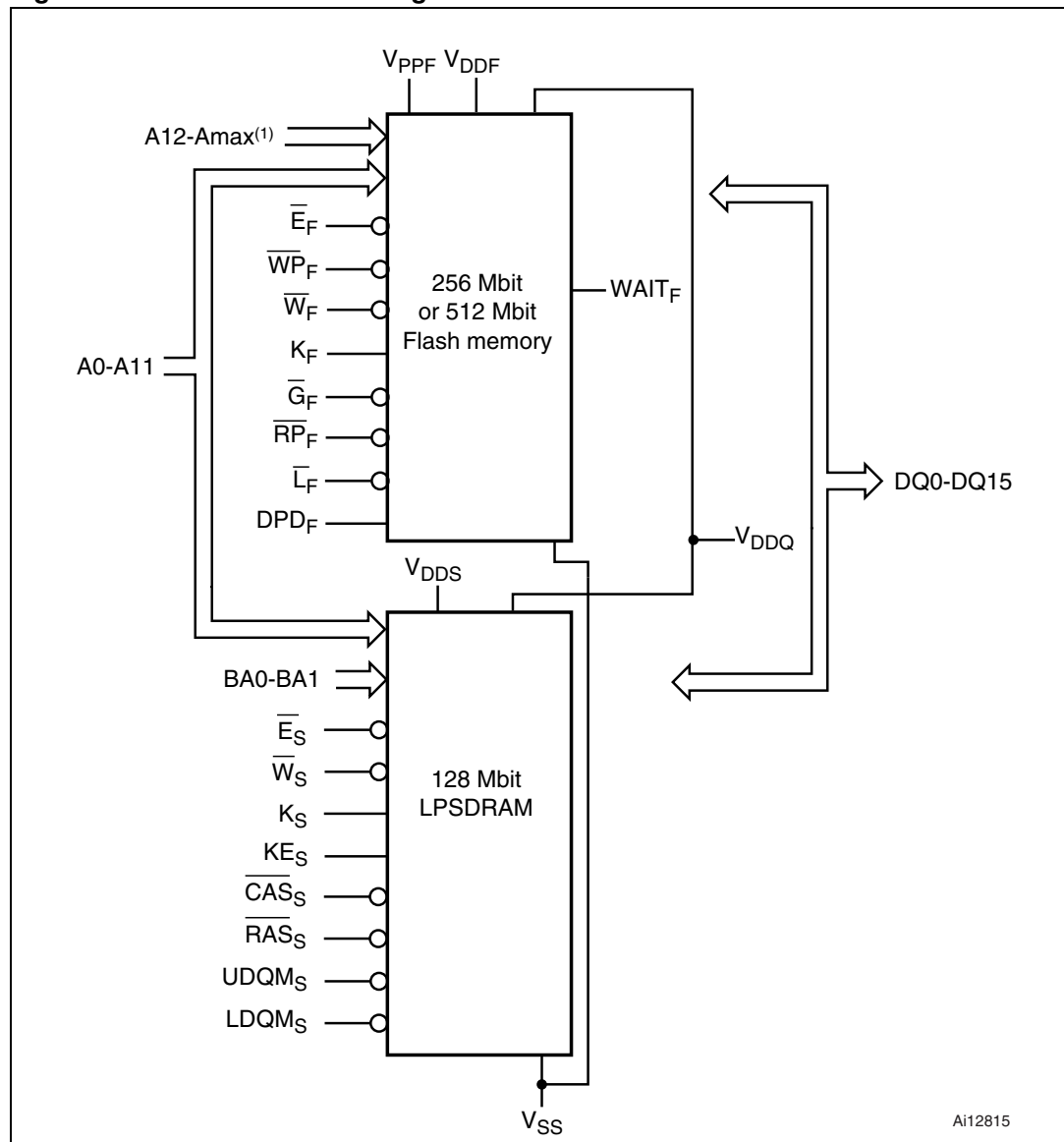
Note: Each device in a system should have V_{DDF} , V_{DDS} , V_{DDQ} and V_{PPH} decoupled with a 0.1 μ F ceramic capacitor close to the pin (high frequency, inherently low inductance capacitors should be as close as possible to the package). See [Figure 5: AC measurement load circuit](#). The PCB track widths should be sufficient to carry the required V_{PPF} program and erase currents.

3 Functional description

The LPSPDRAM and Flash memory components have separate power supplies but share the same grounds. They are distinguished by two Chip Enable inputs: $\overline{E}_F$ for Flash and $\overline{E}_S$ for the LPSPDRAM.

Recommended operating conditions do not allow more than one device to be active at a time. The most common example is a simultaneous read operations on the Flash memory and the LPSPDRAM which would result in a data bus contention. Therefore it is recommended to put the other devices in the high impedance state when reading the selected device.

Figure 3. Functional block diagram



1. Amax is A23 in the M39P0R8070E2 and A24 in the M39P0R9070E2.

Table 2. Bus operations

Operation ⁽¹⁾		$\overline{E}_F$	$\overline{G}_F$	$\overline{W}_F$	$\overline{L}_F$	$\overline{R}P_F$	$WAIT_F$ ⁽²⁾	KE_{Sn-1}	KE_{Sn}	$\overline{E}_S$	$\overline{RAS}_S$	$\overline{CAS}_S$	$\overline{W}_S$	A10	A9, A11	A0-A8	BA0-BA1	DQ15-DQ0
Flash memory ⁽³⁾	Bus Read	V_{IL}	V_{IL}	V_{IH}	$V_{IL}^{(4)}$	V_{IH}				The SDRAM must be disabled.								Data Output
	Bus Write	V_{IL}	V_{IH}	V_{IL}	$V_{IL}^{(4)}$	V_{IH}												Data Input
	Address Latch	V_{IL}	X	V_{IH}	V_{IL}	V_{IH}												Data Output or Hi-Z ⁽⁵⁾
	Output Disable	V_{IL}	V_{IH}	V_{IH}	X	V_{IH}	Hi-Z			Any SDRAM operation mode is allowed.								Hi-Z
	Standby	V_{IH}	X	X	X	V_{IH}	Hi-Z											Hi-Z
	Reset	X	X	X	X	V_{IL}	Hi-Z											Hi-Z
	Deep Power-Down	V_{IH}	X	X	X	V_{IH}	Hi-Z											Hi-Z
LPSDRAM ⁽³⁾	Burst Read	The Flash memory must be disabled.						V_{IH}	X	V_{IL}	V_{IH}	V_{IL}	V_{IH}	V_{IL}	V	SCA ⁽⁶⁾	BS ⁽⁷⁾	Data Output
	Burst Write							V_{IH}	X	V_{IL}	V_{IH}	V_{IL}	V_{IL}	V_{IL}	V	SCA ⁽⁶⁾	BS ⁽⁷⁾	Data Input
	Self Refresh							V_{IH}	V_{IL}	V_{IL}	V_{IL}	V_{IL}	V_{IH}	X			X	—
	Auto Refresh							V_{IH}	V_{IH}	V_{IL}	V_{IL}	V_{IL}	V_{IH}	X			X	—
	Power-Down with Precharge	Any Flash memory operation mode is allowed.						V_{IH}	V_{IL}	V_{IL}	V_{IH}	V_{IH}	V_{IH}	X			X	—
	Deep Power-Down							V_{IH}	V_{IL}	V_{IL}	V_{IH}	V_{IH}	V_{IL}	X			X	—
	Device Deselect							V_{IH}	X	V_{IH}	X	X	X	X			X	—
	No Operation							V_{IH}	X	V_{IL}	V_{IH}	V_{IH}	V_{IH}	X			X	—

1. X = Don't care, V = Valid.

2. $WAIT_F$ signal polarity is configured using the Set Configuration Register command.

3. For further details, refer to the M58PRxxxJ and M65KA128AE datasheets.

4. $\overline{L}_F$ can be tied to V_{IH} if the valid address has been previously latched.

5. Depends on $\overline{G}_F$.

6. SCA = Start Column Address.

7. BS = Bank Select.

4 Maximum rating

Stressing the device above the rating listed in the Absolute Maximum Ratings table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the Numonyx SURE Program and other relevant quality documents.

Table 3. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		Min	Max	
T_A	Ambient Operating Temperature	-25	85	°C
T_J	SDRAM Operating Junction Temperature	-25	85	°C
T_{BIAS}	Temperature Under Bias	-25	85	°C
T_{STG}	Storage Temperature	-55	125	°C
V_{IO}	Input or Output Voltage	-0.5	2.3	V
V_{DDF}	Supply Voltage	-1.0	3.0	V
V_{DDS}	LPSDRAM Supply Voltage	-0.5	2.3	V
V_{DDQ}	Input/Output Supply Voltage	-0.5	2.3	V
V_{PPF}	Program Voltage	-1.0	11.5	V
I_O	Output Short Circuit Current		100	mA
t_{VPPH}	Time for V_{PP} at V_{PPH}		100	hours

5 DC and AC parameters

This section summarizes the operating measurement conditions, and the DC and AC characteristics of the device. The parameters in the DC and AC characteristics Tables that follow, are derived from tests performed under the Measurement Conditions summarized in [Table 4: Operating and AC measurement conditions](#). Designers should check that the operating conditions in their circuit match the operating conditions when relying on the quoted parameters.

Table 4. Operating and AC measurement conditions

Parameter ⁽¹⁾	Flash memory		LPSPDRAM		Unit
	Min	Max	Min	Max	
V _{DDF} Supply Voltage	1.7	1.95	—	—	V
V _{DDS} Supply Voltage	—	—	1.7	1.95	V
V _{DDQ} Supply Voltage	1.7	1.95	1.7	1.95	V
V _{PPF} Supply Voltage (Factory environment)	8.5	9.5	—	—	V
V _{PPF} Supply Voltage (Application environment)	−0.4	V _{DDQ} +0.4	—	—	V
Ambient Operating Temperature	−25	85	−25	85	°C
Load Capacitance (C _L)	30		30		pF
Output Impedance (Z ₀)	50				Ω
Output Circuit Protection Resistance (R)	50				Ω
Input Rise and Fall Times		3	0.5		ns
Input Pulse Voltages	0 to V _{DDQ}		—		V
Output Timing Ref. Voltages	0.3V _{DDQ}	0.7V _{DDQ}	V _{DDQ} /2		V

1. All voltages are referenced to V_{SS} = 0V.

Figure 4. AC measurement I/O waveform

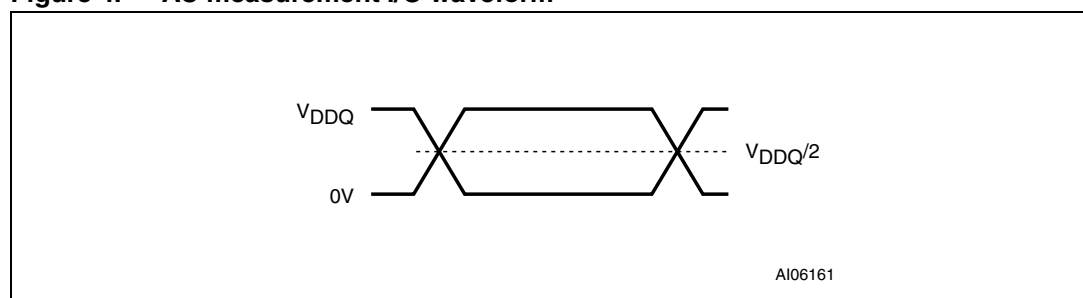


Figure 5. AC measurement load circuit

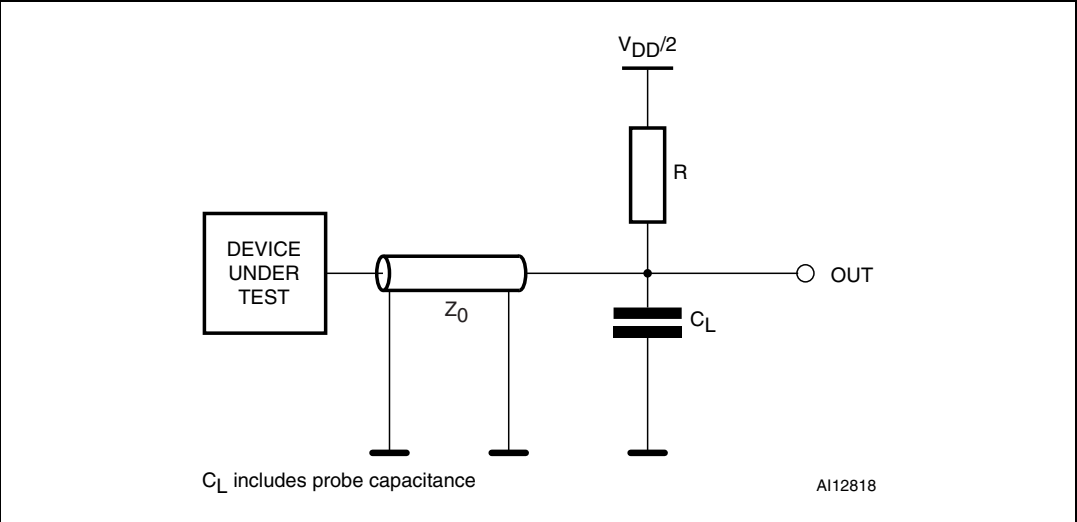


Table 5. Capacitance⁽¹⁾

Symbol	Parameter	Test Condition	Min	Max	Unit
C_{IN}	Input Capacitance	$V_{IN} = 0V$	–	12	pF
C_{OUT}	Output Capacitance	$V_{OUT} = 0V$	–	15	pF

1. Sampled only, not 100% tested.

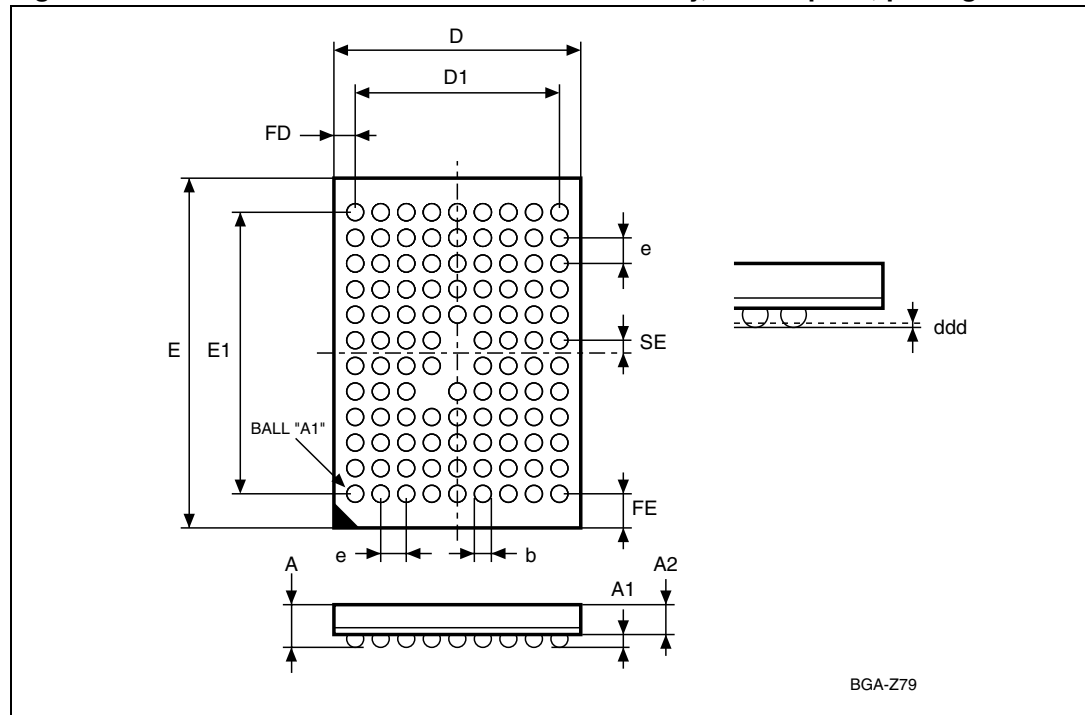
Please refer to the M65KA128AE and M58PRxxxJ datasheets for further DC and AC characteristic values and illustrations.

6 Package mechanical

In order to meet environmental requirements, Numonyx offers these devices in ECOPACK® packages. These packages have a Lead-free second-level interconnect. The category of Second-Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97.

The maximum ratings related to soldering conditions are also marked on the inner box label.

Figure 6. TFBGA105 9x11mm - 9x12 active ball array, 0.8mm pitch, package outline



1. Drawing is not to scale.

Table 6. TFBGA105 9x11mm - 9x12 active ball array, 0.8mm pitch, mechanical data

Symbol	millimeters			inches		
	Typ	Min	Max	Typ	Min	Max
A			1.20			0.047
A1		0.20			0.008	
A2	0.80			0.031		
b	0.35	0.30	0.40	0.014	0.012	0.016
D	9.00	8.90	9.10	0.354	0.350	0.358
D1	6.40			0.252		
ddd			0.10			0.004
E	11.00	10.90	11.10	0.433	0.429	0.437
E1	8.80			0.346		
e	0.80	—	—	0.031	—	—
FD	1.30			0.051		
FE	1.10			0.043		
SE	0.40			0.016		

7 Part numbering

Table 7. Ordering information scheme

Example:	M39	P	0	R	9	0	7	0	E	2	ZAD	E
Device Type												
M39 = Multi-Chip Package (Flash + LPSPDRAM)												
Flash 1 Architecture												
P = Multi-Level, Multiple Bank, Large Buffer												
Flash 2 Architecture												
0 = No Die												
Operating Voltage												
$R = V_{DDF} = V_{DDS} = V_{DDQ} = 1.7 \text{ to } 1.95V$												
Flash 1 Density												
8 = 256 Mbits												
9 = 512 Mbits												
Flash 2 Density												
0 = No Die												
RAM 1 Density												
7 = 128 Mbit												
RAM 0 Density												
0 = No Die												
Parameter Blocks Location												
E = Even Block Flash Memory Configuration												
Product Version												
2 = 90nm Flash technology, 96ns speed; LPSPDRAM												
Package												
ZAD = stacked TFBGA105 D stacked footprint.												
Option												
E = ECOPACK® Package, Standard packing												
F = ECOPACK® Package, Tape & Reel packing												

Note: Devices are shipped from the factory with the memory content bits erased to '1'. For a list of available options (Speed, Package, etc.) or for further information on any aspect of this device, please contact the Numonyx Sales Office nearest to you.

8 Revision history

Table 8. Document revision history

Date	Revision	Changes
03-Apr-2006	0.1	Initial release.
14-Sep-2006	1	Document status promoted from Target specification to full Datasheet. LPSPDRAM Power-up removed from Table 2: Bus operations .
30-Nov-2007	2	Applied Numonyx branding.

Please Read Carefully:

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