

GDDR5 SGRAM

MT51J256M32 – 16 Meg x 32 I/O x 16 banks, 32 Meg x 16 I/O x 16 banks

Features

- $V_{DD} = V_{DDQ} = 1.5V \pm 3\%$ and $1.35V \pm 3\%$
- Data rate: 6.0 Gb/s, 7.0 Gb/s, 8.0 Gb/s
- 16 internal banks
- Four bank groups for $t_{CCDL} = 3 t_{CK}$
- 8n-bit prefetch architecture: 256-bit per array read or write access for x32; 128-bit for x16
- Burst length (BL): 8 only
- Programmable CAS latency: 7–24
- Programmable WRITE latency: 4–7
- Programmable CRC READ latency: 2–3
- Programmable CRC WRITE latency: 8–14
- Programmable EDC hold pattern for CDR
- Precharge: Auto option for each burst access
- Auto refresh and self refresh modes
- Refresh cycles: 16,384 cycles/32ms
- Interface: Pseudo open drain (POD-15) compatible outputs: 40Ω pull-down, 60Ω pull-up
- On-die termination (ODT): 60Ω or 120Ω (NOM)
- ODT and output driver strength auto calibration with external resistor ZQ pin: 120Ω
- Programmable termination and driver strength off-sets
- Selectable external or internal V_{REF} for data inputs; programmable offsets for internal V_{REF}
- Separate external V_{REF} for address/command inputs
- x32/x16 mode configuration set at power-up with EDC pin
- Single-ended interface for data, address, and command
- Quarter data rate differential clock inputs CK_t, CK_c for address and commands
- Two half data rate differential clock inputs, WCK_t and WCK_c, each associated with two data bytes (DQ, DBI_n, EDC)
- DDR data (WCK) and addressing (CK)
- SDR command (CK)
- Write data mask function via address bus (single/double byte mask)
- Data bus inversion (DBI) and address bus inversion (ABI)
- Digital RAS lockout

- Address training: Address input monitoring via DQ pins
- WCK2CK clock training: Phase information via EDC pins
- Data read and write training via read FIFO (FIFO depth = 6)
- Read FIFO pattern preloaded by LDFF command
- Direct write data load to read FIFO by WRTR command
- Consecutive read of read FIFO by RDTR command
- Read/write data transmission integrity secured by cyclic redundancy check (CRC-8)
- Read/write EDC on/off mode
- Low power modes
- RDQS mode on EDC pin
- On-die temperature sensor with readout
- Automatic temperature sensor controlled self refresh rate
- Vendor ID, FIFO depth and density info fields for identification
- Mirror function with MF pin
- Boundary scan function with SEN pin
- Lead-free (RoHS-compliant) and halogen-free packaging
- $T_C = 0^\circ\text{C}$ to $+95^\circ\text{C}$

Options¹

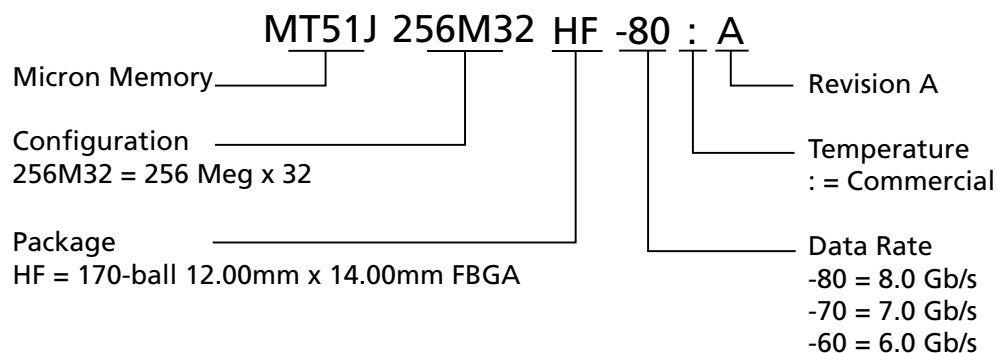
- Organization
 - 256 Meg x 32 (words x bits)
- FBGA package
 - 170-ball (12mm x 14mm)
- Timing – maximum data rate
 - 6.0 Gb/s, 5.0 Gb/s
 - 7.0 Gb/s, 6.0 Gb/s
 - 8.0 Gb/s, 6.0 Gb/s
- Operating temperature
 - Commercial ($0^\circ\text{C} \leq T_C \leq +95^\circ\text{C}$)
- Revision

Marking

256M32
HF
-60
-70
-80
None
A

Note: 1. Not all options listed can be combined to define an offered product. Use the part catalog search on <http://www.micron.com> for available offerings.

Figure 1: Part Numbering



Note: 1. This Micron GDDR5 SGRAM is available in different speed bins. The operating range and AC timings of a faster speed bin are a superset of all slower speed bins. Therefore it is safe to use a faster bin device as a drop-in replacement of a slower bin device when operated within the supply voltage and frequency range of the slower bin device.

FBGA Part Marking Decoder

Due to space limitations, FBGA-packaged components have an abbreviated part marking that is different from the part number. For a quick conversion of an FBGA code, see the FBGA Part Marking Decoder on Micron's web site: <http://www.micron.com>.

Ball Assignments and Descriptions

Figure 2: 170-Ball FBGA – MF = 0 (Top View)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	V _{SSQ}	DQ1	V _{SSQ}	DQ0	NC					V _{REFD}	DQ8	V _{SSQ}	DQ9	V _{SSQ}
B	V _{DDQ}	DQ3	V _{DDQ}	DQ2	V _{SS}					V _{SS}	DQ10	V _{DDQ}	DQ11	V _{DDQ}
C	V _{SSQ}	EDC0	V _{SSQ}	V _{SSQ}	V _{DD}					V _{DD}	V _{SSQ}	V _{SSQ}	EDC1	V _{SSQ}
D	V _{DDQ}	DBI0_n	V _{DDQ}	WCK01_t	WCK01_c					V _{SS}	V _{DD}	V _{DDQ}	DBI1_n	V _{DDQ}
E	V _{SSQ}	DQ5	V _{SSQ}	DQ4	V _{DDQ}					V _{DDQ}	DQ12	V _{SSQ}	DQ13	V _{SSQ}
F	V _{DDQ}	DQ7	V _{DDQ}	DQ6	V _{SSQ}					V _{SSQ}	DQ14	V _{DDQ}	DQ15	V _{DDQ}
G	V _{DD}	V _{DDQ}	RAS_n	V _{DD}	V _{SS}					V _{SS}	V _{DD}	CS_n	V _{DDQ}	V _{DD}
H	V _{SS}	V _{SSQ}	V _{DDQ}	A10, A0	A9, A1					BA3, A3	BA0, A2	V _{DDQ}	V _{SSQ}	V _{SS}
J	MF	RESET_n	CKE_n	AB1_n	A12, A13					SEN	CK_c	CK_t	ZQ	V _{REFC}
K	V _{SS}	V _{SSQ}	V _{DDQ}	A8, A7	A11, A6					BA1, A5	BA2, A4	V _{DDQ}	V _{SSQ}	V _{SS}
L	V _{DD}	V _{DDQ}	CAS_n	V _{DD}	V _{SS}					V _{SS}	V _{DD}	WE_n	V _{DDQ}	V _{DD}
M	V _{DDQ}	DQ31	V _{DDQ}	DQ30	V _{SSQ}					V _{SSQ}	DQ22	V _{DDQ}	DQ23	V _{DDQ}
N	V _{SSQ}	DQ29	V _{SSQ}	DQ28	V _{DDQ}					V _{DDQ}	DQ20	V _{SSQ}	DQ21	V _{SSQ}
P	V _{DDQ}	DBI3_n	V _{DDQ}	WCK23_t	WCK23_c					V _{SS}	V _{DD}	V _{DDQ}	DBI2_n	V _{DDQ}
R	V _{SSQ}	EDC3	V _{SSQ}	V _{SSQ}	V _{DD}					V _{DD}	V _{SSQ}	V _{SSQ}	EDC2	V _{SSQ}
T	V _{DDQ}	DQ27	V _{DDQ}	DQ26	V _{SS}					V _{SS}	DQ18	V _{DDQ}	DQ19	V _{DDQ}
U	V _{SSQ}	DQ25	V _{SSQ}	DQ24	NC					V _{REFD}	DQ16	V _{SSQ}	DQ17	V _{SSQ}

(Top view)

Data
 Addresses
 GDDR5
 Supply
 Ground

Note: 1. Balls shown with a heavy, solid outline are off in x16 mode.

Figure 3: 170-Ball FBGA – MF = 1 (Top View)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	V _{SSQ}	DQ25	V _{SSQ}	DQ24	NC					V _{REFD}	DQ16	V _{SSQ}	DQ17	V _{SSQ}
B	V _{DDQ}	DQ27	V _{DDQ}	DQ26	V _{SS}					V _{SS}	DQ18	V _{DDQ}	DQ19	V _{DDQ}
C	V _{SSQ}	EDC3	V _{SSQ}	V _{SSQ}	V _{DD}					V _{DD}	V _{SSQ}	V _{SSQ}	EDC2	V _{SSQ}
D	V _{DDQ}	DBI3_n	V _{DDQ}	WCK23_t	WCK23_c					V _{SS}	V _{DD}	V _{DDQ}	DBI2_n	V _{DDQ}
E	V _{SSQ}	DQ29	V _{SSQ}	DQ28	V _{DDQ}					V _{DDQ}	DQ20	V _{SSQ}	DQ21	V _{SSQ}
F	V _{DDQ}	DQ31	V _{DDQ}	DQ30	V _{SSQ}					V _{SSQ}	DQ22	V _{DDQ}	DQ23	V _{DDQ}
G	V _{DD}	V _{DDQ}	CAS_n	V _{DD}	V _{SS}					V _{SS}	V _{DD}	WE_n	V _{DDQ}	V _{DD}
H	V _{SS}	V _{SSQ}	V _{DDQ}	A8, A7	A11, A6					BA1, A5	BA2, A4	V _{DDQ}	V _{SSQ}	V _{SS}
J	MF	RESET_n	CKE_n	AB1_n	A12, A13					SEN	CK_c	CK_t	ZQ	V _{REFC}
K	V _{SS}	V _{SSQ}	V _{DDQ}	A10, A0	A9, A1					BA3, A3	BA0, A2	V _{DDQ}	V _{SSQ}	V _{SS}
L	V _{DD}	V _{DDQ}	RAS_n	V _{DD}	V _{SS}					V _{SS}	V _{DD}	CS_n	V _{DDQ}	V _{DD}
M	V _{DDQ}	DQ7	V _{DDQ}	DQ6	V _{SSQ}					V _{SSQ}	DQ14	V _{DDQ}	DQ15	V _{DDQ}
N	V _{SSQ}	DQ5	V _{SSQ}	DQ4	V _{DDQ}					V _{DDQ}	DQ12	V _{SSQ}	DQ13	V _{SSQ}
P	V _{DDQ}	DBI0_n	V _{DDQ}	WCK01_t	WCK01_c					V _{SS}	V _{DD}	V _{DDQ}	DBI1_n	V _{DDQ}
R	V _{SSQ}	EDC0	V _{SSQ}	V _{SSQ}	V _{DD}					V _{DD}	V _{SSQ}	V _{SSQ}	EDC1	V _{SSQ}
T	V _{DDQ}	DQ3	V _{DDQ}	DQ2	V _{SS}					V _{SS}	DQ10	V _{DDQ}	DQ11	V _{DDQ}
U	V _{SSQ}	DQ1	V _{SSQ}	DQ0	NC					V _{REFD}	DQ8	V _{SSQ}	DQ9	V _{SSQ}

(Top view)



Note: 1. Balls shown with a heavy, solid outline are off in x16 mode.

Table 1: 170-Ball FBGA Ball Descriptions

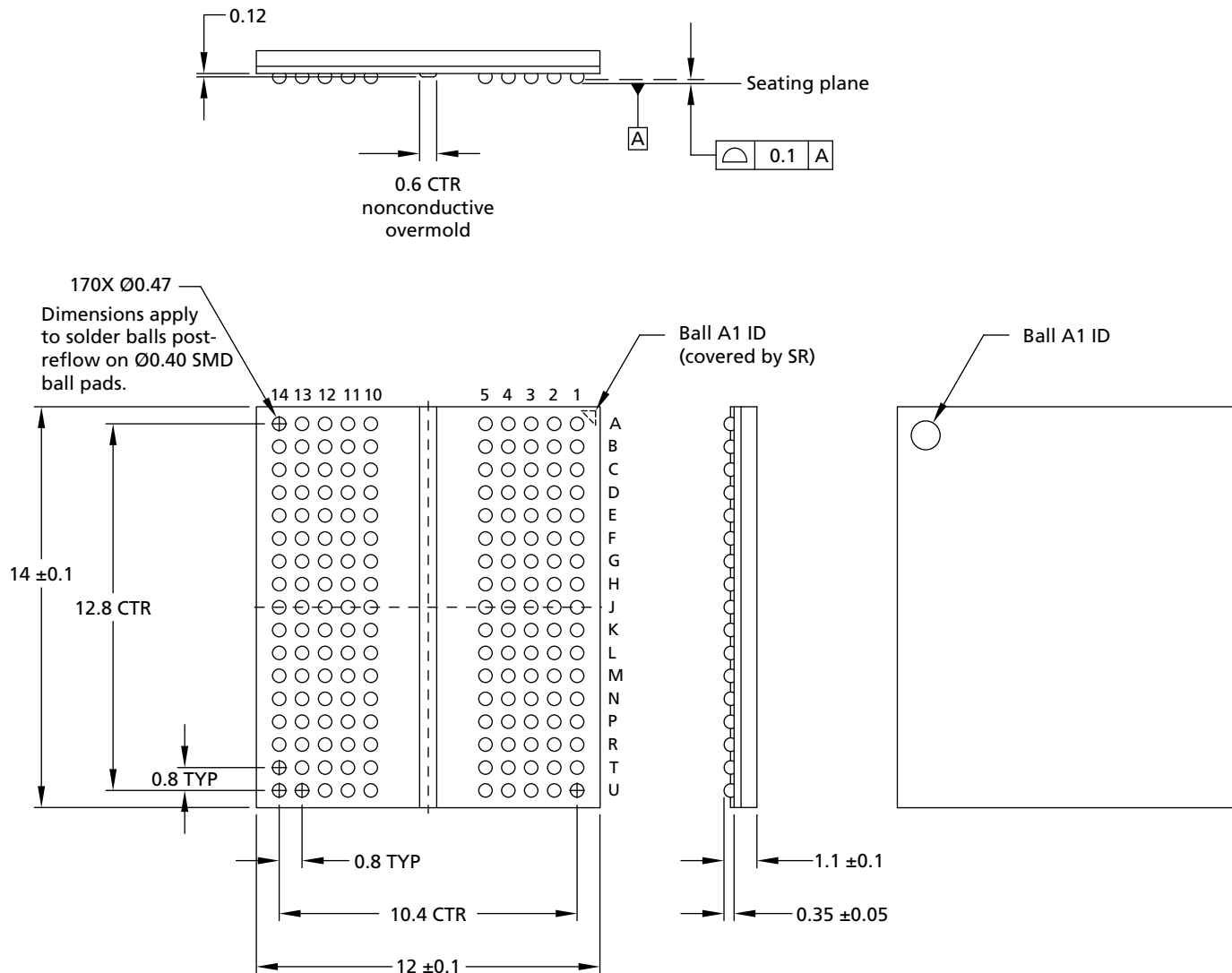
Symbol	Type	Description
A[13:0]	Input	Address inputs: Provide the row address for ACTIVE commands. A[6:0] (A7) provide the column address and A8 defines the auto precharge bit for READ/WRITE commands, to select one location out of the memory array in the respective bank. A8 sampled during a PRECHARGE command determines whether the PRECHARGE applies to one bank (A8 LOW, bank selected by BA[3:0]) or all banks (A8 HIGH). The address inputs also provide the op-code during a MODE REGISTER SET command and the data bits during LDFF commands. A[12:8] are sampled with the rising edge of CK_t and A[7:0], A13 are sampled with the rising edge of CK_c.
ABI_n	Input	Address bus inversion: Reduces the power requirements on address pins by limiting the number of address lines driving LOW to 5. ABI_n is enabled by the corresponding ABI mode register bit.
BA[3:0]	Input	Bank address inputs: Define the bank to which an ACTIVE, READ, WRITE, or PRECHARGE command is being applied. BA[3:0] define which mode register is loaded during the MODE REGISTER SET command. BA[3:0] are sampled with the rising edge of CK_t.
CK_t, CK_c	Input	Clock: CK_t and CK_c are differential clock inputs. Command inputs are latched on the rising edge of CK_t. Address inputs are latched on the rising edge of CK_t and the rising edge of CK_c. All latencies are referenced to CK_t. CK_t and CK_c are externally terminated.
WCK01_t, WCK01_c/ WCK23_t, WCK23_c	Input	Data Clocks: WCK_t and WCK_c are differential clocks used for write data capture and read data output. WCK01_t and WCK01_c are associated with DQ[15:0], DBI0_n, DBI1_n, EDC0, and EDC1. WCK23_t and WCK23_c are associated with DQ[31:16], DBI2_n, DBI3_n, EDC2, and EDC3. WCK clocks operate at nominally twice the CK clock frequency.
CKE_n	Input	Clock enable: CKE_n enables (registered LOW) and disables (registered HIGH) internal circuitry and clocks on the device. The specific circuitry that is enabled/disabled is dependent upon the device configuration and operating mode. Taking CKE_n HIGH provides PRECHARGE POWER-DOWN and SELF REFRESH operations (all banks idle), or active power-down (row active in any bank). CKE_n is synchronous for power-down entry and exit and for self refresh entry. CKE_n must be maintained LOW throughout read and write accesses. Input buffers (excluding CKE_n) are disabled during SELF REFRESH operation. The value of CKE_n latched at power-up with RESET_n going HIGH determines the termination value of the address and command inputs.
CS_n	Input	Chip select: CS_n enables (registered LOW) and disables (registered HIGH) the command decoder. All commands are masked when CS_n is registered HIGH, but internal command execution continues. CS_n is considered part of the command code.
MF	Input	Mirror function: V _{DDQ} CMOS input. Must be tied to V _{DDQ} or V _{SS} .
RAS_n, CAS_n, WE_n	Input	Command inputs: RAS_n, CAS_n, and WE_n (along with CS_n) define the command being entered.
RESET_n	Input	Reset: RESET_n is an active LOW CMOS input referenced to V _{SS} . A full chip reset may be performed at any time by pulling RESET_n LOW. With RESET_n LOW all ODTs are disabled.
SEN	Input	Scan enable: V _{DDQ} CMOS input. Must be tied to V _{SS} when not in use.

Table 1: 170-Ball FBGA Ball Descriptions (Continued)

Symbol	Type	Description
DQ[31:0]	I/O	Data input/output: Bidirectional 32-bit data bus.
DBI[3:0]_n	I/O	Data bus inversion: Reduces the DC power consumption and supply noise induced jitter on data pins. DBI0_n is associated with DQ[7:0], DBI1_n with DQ[15:8], DBI2_n with DQ[23:16], and DBI3_n with DQ[31:24].
EDC[3:0]	Output	Error detection code: The calculated CRC data is transmitted on these pins. In addition, these pins drive a hold pattern when idle and can be used as an RDQS function. EDC0 is associated with DQ[7:0], EDC1 with DQ[15:8], EDC2 with DQ[23:16], and EDC3 with DQ[31:24].
V _{DD}	Supply	Power supply: 1.5V $\pm$ 3% and 1.35V $\pm$ 3%.
V _{DDQ}	Supply	DQ power supply: 1.5V $\pm$ 3% and 1.35V $\pm$ 3%. Isolated on the device for improved noise immunity.
V _{REFC}	Supply	Reference voltage for control and address: V _{REFC} must be maintained at all times (including self refresh) for proper device operation.
V _{REFD}	Supply	Reference voltage for data: V _{REFD} must be maintained at all times (including self refresh) for proper device operation.
V _{SS}	Supply	Ground.
V _{SSQ}	Supply	DQ ground: Isolated on the device for improved noise immunity.
ZQ	Reference	External reference ball for impedance calibration: This ball is tied to an external 120 Ω resistor (ZQ), which is tied to V _{SSQ} .
NC	–	No connect: These balls should be left unconnected (the ball has no connection to the device or to other balls).

Package Dimensions

Figure 4: 170-Ball FBGA (BG)



- Notes: 1. All dimensions are in millimeters.
2. Solder ball material: SAC-Q (92.5% Sn, 4% Ag, 3% Bi, 0.5% Cu).

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 Although considered final, these specifications are subject to change, as further product development and data characterization some-
 times occur.

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