- **Organization: 2 097 152 x 64 Bits**
- **Single 3.3-V Power Supply (±10% Tolerance)**
- **Designed for 66-MHz 4-Clock Systems**
- **JEDEC 144-Pin Small-Outline Dual-In-Line Memory Module (SODIMM) Without Buffer for Use With Socket**
- **Uses Eight 16M-Bit Synchronous Dynamic RAMs (SDRAMs) (2M × 8-Bit) in Plastic Thin Small-Outline Packages (TSOPs)**
- **Byte-Read/Write Capability**
- **Read Latencies 2 and 3 Supported**
- **Performance Ranges:**
- **Support Burst-Interleave and Burst-Interrupt Operations**
- **Burst Length Programmable to 1, 2, 4, and 8**
- **Two Banks for On-Chip Interleaving (Gapless Access)**
- **Ambient Temperature Range 0°C to 70°C**
- **Gold-Plated Contacts**
- **Pipeline Architecture**
- **High-Speed, Low-Noise Low-Voltage TTL (LVTTL) Interface**
- **Serial Presence Detect (SPD) Using EEPROM**

	SYNCHRONOUS CLOCK CYCLE TIME		ACCESS TIME CLOCK TO OUTPUT		REFRESH INTERVAL
	t_{CK3} (CL = 3)‡	t_{CK2} (CL = 2)	t_{AC3} (CL = 3)	t_{AC2} (CL = 2)	
'xSJ64EPU-12A†	12 ns	15 ns	9 ns	9 ns	64 ms
'xSJ64EPU-12	12 ns	18 ns	9 ns	10 ns	64 ms

† −12A speed device is supported only at −5 to 10% V_{DD}
‡ CL = CAS latency

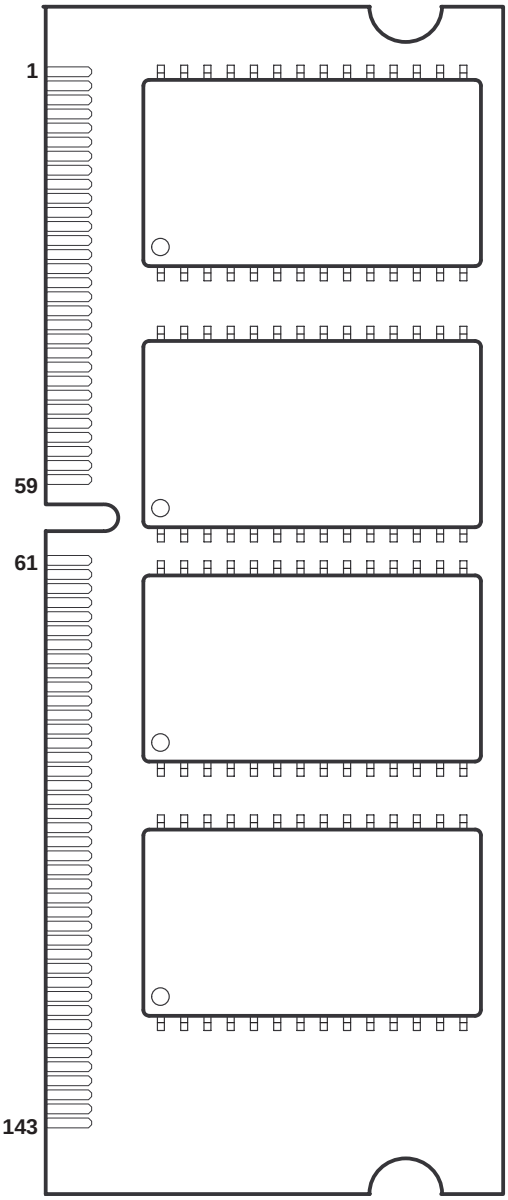
description

The TM2SJ64EPU is a 16M-byte, 144-pin small-outline dual-in-line memory module (SODIMM). The SODIMM is composed of eight TMS626812DGE, 2097152 x 8-bit SDRAMs, each in a 400-mil, 44-pin plastic thin small-outline package (TSOP) mounted on a substrate with decoupling capacitors. See the TMS626812 data sheet (literature number SMOS687).

operation

The TM2SJ64EPU operates as eight TMS626812DGE devices that are connected as shown in the TM2SJ64EPU functional block diagram.

DUAL-IN-LINE MEMORY MODULE (TOP VIEW)



TM2SJ64EPU (SIDE VIEW)

PIN NOMENCLATURE

A[0:10]	Row Address Inputs
A[0:8]	Column Address Inputs
A11/BA0, BA1	Bank-Select
$\overline{CAS}$	Column-Address Strobe
CKE[0:1]	Clock Enable
CK[0:3]	System Clock
DQ[0:63]	Data-In/Data-Out
DQMB[0:7]	Data-In/Data-Out Mask Enable
NC	No Connect
$\overline{RAS}$	Row-Address Strobe
$\overline{S0}$, $\overline{S1}$	Chip-Select
SCL	SPD Clock
SDA	SPD Address/Data
V_{DD}	3.3-V Supply
V_{SS}	Ground
$\overline{WE}$	Write Enable

Pin Assignments

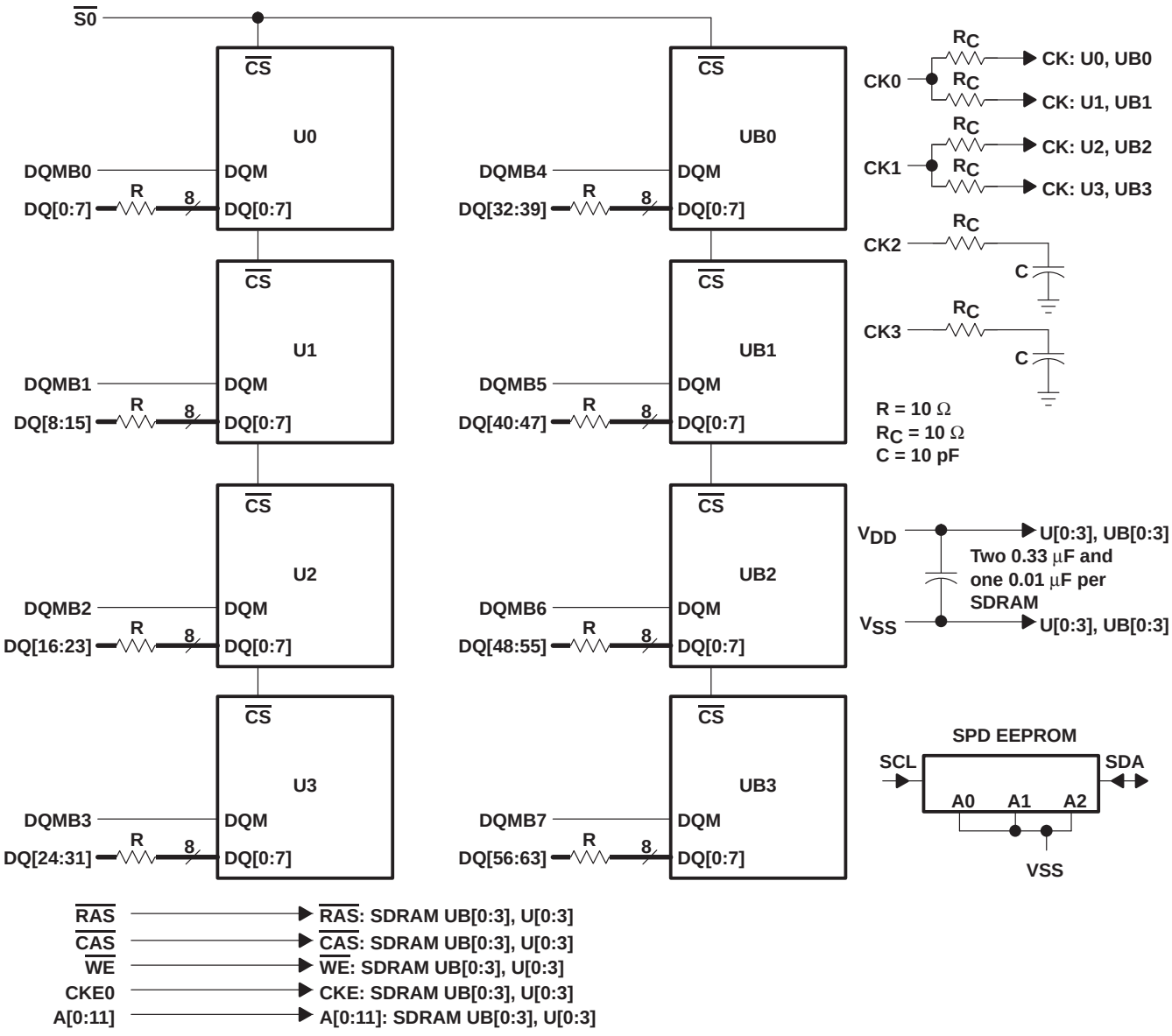
PIN NO.	PIN NAME	PIN NO.	PIN NAME	PIN NO.	PIN NAME	PIN NO.	PIN NAME
1	V_{SS}	37	DQ8	73	NC	109	A9
2	V_{SS}	38	DQ40	74	CK1	110	BA1
3	DQ0	39	DQ9	75	V_{SS}	111	A10
4	DQ32	40	DQ41	76	V_{SS}	112	A11
5	DQ1	41	DQ10	77	NC	113	V_{DD}
6	DQ33	42	DQ42	78	NC	114	V_{DD}
7	DQ2	43	DQ11	79	NC	115	DQMB2
8	DQ34	44	DQ43	80	NC	116	DQMB6
9	DQ3	45	V_{DD}	81	V_{DD}	117	DQMB3
10	DQ35	46	V_{DD}	82	V_{DD}	118	DQMB7
11	V_{DD}	47	DQ12	83	DQ16	119	V_{SS}
12	V_{DD}	48	DQ44	84	DQ48	120	V_{SS}
13	DQ4	49	DQ13	85	DQ17	121	DQ24
14	DQ36	50	DQ45	86	DQ49	122	DQ56
15	DQ5	51	DQ14	87	DQ18	123	DQ25
16	DQ37	52	DQ46	88	DQ50	124	DQ57
17	DQ6	53	DQ15	89	DQ19	125	DQ26
18	DQ38	54	DQ47	90	DQ51	126	DQ58
19	DQ7	55	V_{SS}	91	V_{SS}	127	DQ27
20	DQ39	56	V_{SS}	92	V_{SS}	128	DQ59
21	V_{SS}	57	NC	93	DQ20	129	V_{DD}
22	V_{SS}	58	NC	94	DQ52	130	V_{DD}
23	DQMB0	59	NC	95	DQ21	131	DQ28
24	DQMB4	60	NC	96	DQ53	132	DQ60
25	DQMB1	61	CK0	97	DQ22	133	DQ29
26	DQMB5	62	CKE0	98	DQ54	134	DQ61
27	V_{DD}	63	V_{DD}	99	DQ23	135	DQ30
28	V_{DD}	64	V_{DD}	100	DQ55	136	DQ62
29	A0	65	$\overline{RAS}$	101	V_{DD}	137	DQ31
30	A3	66	$\overline{CAS}$	102	V_{DD}	138	DQ63
31	A1	67	$\overline{WE}$	103	A6	139	V_{SS}
32	A4	68	CKE1	104	A7	140	V_{SS}
33	A2	69	$\overline{S0}$	105	A8	141	SDA
34	A5	70	NC	106	A11/BA0	142	SCL
35	V_{SS}	71	$\overline{S1}$	107	V_{SS}	143	V_{DD}
36	V_{SS}	72	NC	108	V_{SS}	144	V_{DD}

small-outline dual-in-line memory module and components

The small-outline dual-in-line memory module and components include:

- PC substrate: 1,10 ± 0,1 mm (0.04 inch) nominal thickness
- Bypass capacitors: Multilayer ceramic
- Contact area: Nickel plate and gold plate over copper

functional block diagram



Legend:
CS = Chip select
SPD = Serial presence detect

absolute maximum ratings over ambient temperature range (unless otherwise noted)†

Supply voltage range, V_{DD} . . . . . −0.5 V to 4.6 V
Voltage range on any pin (see Note 1) . . . . . − 0.5 V to 4.6 V
Short-circuit output current . . . . . 50 mA
Power dissipation: . . . . . 8 W
Ambient temperature range, T_A . . . . . 0°C to 70°C
Storage temperature range, T_{stg} . . . . . − 55°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to V_{SS}.

recommended operating conditions

		MIN	NOM	MAX	UNIT
V_{DD}	Supply voltage	3	3.3	3.6	V
V_{SS}	Supply voltage		0		V
V_{IH}	High-level input voltage	2		V_{DD} + 0.3	V
V_{IH-SPD}	High-level input voltage for the SPD device	2		5.5	V
V_{IL}	Low-level input voltage ‡	−0.3		0.8	V
T_A	Ambient temperature	0		70	°C

‡ V_{IL} MIN = −1.5 V ac (pulse width ≤ 5 ns)

capacitance over recommended ranges of supply voltage and ambient temperature, f = 1 MHz (see Note 2)§

PARAMETERS		TM2SJ64EPU		UNIT
		MIN	MAX	
$C_{i(CK)}$	Input capacitance, CK input		5	pF
$C_{i(AC)}$	Input capacitance, address and control inputs: A0−A11, $\overline{RAS}$x, $\overline{CAS}$x, $\overline{WE}$x		5	pF
$C_{i(CKE)}$	Input capacitance, CKE input		5	pF
C_o	Output capacitance		8	pF
$C_{i(DQMBx)}$	Input capacitance, DQMBx input		5	pF
$C_{i(Sx)}$	Input capacitance, $\overline{Sx}$ input		5	pF
$C_{i/o(SDA)}$	Input/output capacitance, SDA input		9	pF
$C_{i(SPD)}$	Input capacitance, SPD inputs (except SDA)		7	pF

§ Specifications in this table represent a single SDRAM device.

NOTE 2: V_{DD} = 3.3 V ± 0.3 V. Bias on pins under test is 0 V.

electrical characteristics over recommended ranges of supply voltage and ambient temperature (unless otherwise noted) (see Note 3)†

PARAMETER		TEST CONDITIONS		'2SJ64EPU-12A		'2SJ64EPU-12		UNIT
				MIN	MAX	MIN	MAX	
V_{OH}	High-level output voltage	I_{OH} = − 2 mA		2.4		2.4		V
V_{OL}	Low-level output voltage	I_{OL} = 2 mA			0.4		0.4	V
I_I	Input current (leakage)	0 V < V_I < V_{DD} + 0.3 V, All other pins = 0 V to V_{DD}			±10		±10	µA
I_O	Output current (leakage)	0 V < V_O < V_{DD} +0.3 V,	Output disabled		±10		±10	µA
I_{CC1}	Operating current	Burst length = 1, $t_{RC} \geq t_{RC}$ MIN, I_{OH}/I_{OL} = 0 mA, one bank activated (see Note 4)	CAS latency = 2		85		75	mA
			CAS latency = 3		95		95	mA
I_{CC2P}	Precharge standby current in power-down mode	CKE ≤ V_{IL} MAX, t_{CK} = 15 ns (see Note 5)			2		2	mA
I_{CC2PS}		CKE and CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			2		2	mA
I_{CC2N}	Precharge standby current in non-power-down mode	CKE ≥ V_{IH} MIN, t_{CK} = 15 ns (see Note 5)			30		30	mA
I_{CC2NS}		CKE ≥ V_{IH} MIN, CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			2		2	mA
I_{CC3P}	Active standby current in power-down mode	CKE ≤ V_{IL} MAX, t_{CK} = 15 ns (see Note 5)			8		8	mA
I_{CC3PS}		CKE and CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			8		8	mA
I_{CC3N}	Active standby current in non-power-down mode	CKE ≥ V_{IH} MIN, t_{CK} = 15 ns (see Note 5)			35		35	mA
I_{CC3NS}		CKE ≥ V_{IH} MIN, CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			10		10	mA
I_{CC4}	Burst current	Page burst, I_{OH}/I_{OL} = 0 mA All banks activated, n_{CCD} = one cycle (see Note 7)	CAS latency = 2		130		110	mA
			CAS latency = 3		155		155	mA
I_{CC5}	Auto-refresh current	$t_{RC} \leq t_{RC}$ MIN	CAS latency = 2		75		70	mA
			CAS latency = 3		85		85	mA
I_{CC6}	Self-refresh current	CKE ≤ V_{IL} MAX			2		2	mA

† Specifications in this table represent a single SDRAM device.

NOTES: 3. All specifications apply to the device after power-up initialization. All control and address inputs must be stable and valid.
4. Control, DQ, and address inputs change state twice during t_{RC}.
5. Control, DQ, and address inputs change state once every 30 ns.
6. Control, DQ, and address inputs do not change.
7. Control, DQ, and address inputs change once every cycle.

ac timing requirements †‡

		'2SJ64EPU-12A§		'2SJ64EPU-12		UNIT
		MIN	MAX	MIN	MAX	
t_{AC2}	Access time, CK high to data out, CAS latency = 2 (see Note 8)		9		10	ns
t_{AC3}	Access time, CK high to data out, CAS latency = 3 (see Note 8)		9		9	ns
t_{CK2}	Cycle time, CK, CAS latency = 2	15		18		ns
t_{CK3}	Cycle time, CK, CAS latency = 3	12		12		ns
t_{LZ}	Delay time, CK high to DQ in low-impedance state (see Note 9)	3		3		ns
t_{HZ}	Delay time, CK high to DQ in high-impedance state (see Note 10)		10		10	ns
t_{RAS}	Delay time, ACTV command to DEAC or DCAB command	60	100000	72	100000	ns
t_{RC}	Delay time, ACTV, MRS, REFR, or SLFR to ACTV, MRS, REFR, or SLFR command	90		108		ns
t_{RCD}	Delay time, ACTV command to READ, READ-P, WRT, or WRT-P command (see Note 11)	30		30		ns
t_{RP}	Delay time, DEAC or DCAB command to ACTV, MRS, REFR, or SLFR command	30		36		ns
t_{RRD}	Delay time, ACTV command in one bank to ACTV command in the other bank	24		24		ns
t_{RSA}	Delay time, MRS command to ACTV, MRS, REFR, or SLFR command	24		24		ns
t_{APR}	Final data out of READ-P operation to ACTV, MRS, SLFR, or REFR command	$t_{RP} - (CL - 1) * t_{CK}$				ns
t_{OH}	Hold time, CK high to data out	3		3		ns
t_{IH}	Hold time, address, control, and data input	1		1.5		ns
t_{CESP}	Power down/self-refresh exit time	10		10		ns
t_{CH}	Pulse duration, CK high	4		4		ns
t_{CL}	Pulse duration, CK low	4		4		ns
t_{IS}	Setup time, address, control, and data input	3		3		ns
t_{APW}	Final data in of WRT-P operation to ACTV, MRS, SLFR, or REFR command	60		60		ns
t_{WR}	Delay time, final data in of WRT operation to DEAC or DCAB command	15		20		ns
t_T	Transition time (see Note 12)	1	5	1	5	ns
t_{REF}	Refresh interval		64		64	ms
n_{CCD}	Delay time, READ or WRT command to an interrupting command	1		1		cycle
n_{CDD}	Delay time, CS low or high to input enabled or inhibited	0	0	0	0	cycle
n_{CLE}	Delay time, CKE high or low to CK enabled or disabled	1	1	1	1	cycle
n_{CWL}	Delay time, final data in of WRT operation to READ, READ-P, WRT, WRT-P	1		1		cycle
n_{DID}	Delay time, ENBL or MASK command to enabled or masked data in	0	0	0	0	cycle
n_{DOD}	Delay time, ENBL or MASK command to enabled or masked data out	2	2	2	2	cycle
n_{HZP2}	Delay time, DEAC or DCAB command to DQ in high-impedance state, CAS latency = 2		2		2	cycle
n_{HZP3}	Delay time, DEAC or DCAB command to DQ in high-impedance state, CAS latency = 3		3		3	cycle
n_{WCD}	Delay time, WRT command to first data in	0	0	0	0	cycle

† All references are made to the rising transition of CK unless otherwise noted.
‡ Specifications in this table represent a single SDRAM device.
§ -12A speed device is supplied only at − 5% to +10% V_{DD}

NOTES: 8. t_{AC} is referenced from the rising transition of CK that is previous to the data-out cycle. For example, the first data out t_{AC} is referenced from the rising transition of CKx that is CAS latency − one cycle after the READ command. Access time is measured at output reference level 1.4 V.
9. t_{LZ} is measured from the rising transition of CLK that is CAS latency − one cycle after the READ command.
10. t_{HZ} MAX defines the time at which the outputs are no longer driven and is not referenced to output voltage levels.
11. For read or write operations with automatic deactivate, t_{RCD} must be set to satisfy minimum t_{RAS}.
12. Transition time, t_T, is measured between V_{IH} and V_{IL}.

serial presence detect

The serial presence detect (SPD) is contained in a 2K-bit serial EEPROM located on the module. The SPD nonvolatile EEPROM contains various data such as module configuration, SDRAM organization, and timing parameters (see Table 1). Only the first 128 bytes are programmed by Texas Instruments, while the remaining 128 bytes are available for customer use. Programming is done through an IIC bus using the clock (SCL) and data (SDA) signals. All Texas Instruments modules comply with the current JEDEC SPD Standard. See the *Texas Instruments Serial Presence Detect Technical Reference* (literature number SMMU001) for further details.

Table 1 lists the functions of the TM2SJ64EPU.

Table 1. Serial Presence Detect Data

BYTE NO.	DESCRIPTION OF FUNCTION	TM2SJ64EPU-12A		TM2SJ64EPU-12	
		ITEM	DATA	ITEM	DATA
0	Defines number of bytes written into serial memory during module manufacturing	128 bytes	80h	128 bytes	80h
1	Total number of bytes of SPD memory device	256 bytes	08h	256 bytes	08h
2	Fundamental memory type (FPM, EDO, SDRAM, . . .)	SDRAM	04h	SDRAM	04h
3	Number of row addresses on this assembly	11	0Bh	11	0Bh
4	Number of column addresses on this assembly	9	09h	9	09h
5	Number of module rows on this assembly	1 bank	01h	1 bank	01h
6	Data width of this assembly	64 bits	40h	64 bits	40h
7	Data width continuation		00h		00h
8	Voltage interface standard of this assembly	LVTTL	01h	LVTTL	01h
9	SDRAM cycle time at maximum supported CAS latency (CL), CL = X	t_{CK} = 12 ns	C0h	t_{CK} = 12 ns	C0h
10	SDRAM access from clock at CL = X	t_{AC} = 9 ns	90h	t_{AC} = 9 ns	90h
11	SODIMM configuration type (non-parity, parity, error-correcting code [ECC])	Non-Parity	00h	Non-Parity	00h
12	Refresh rate/type	15.6 µs/ self-refresh	80h	15.6 µs/ self-refresh	80h
13	SDRAM width, primary DRAM	x8	08h	x8	08h
14	Error-checking SDRAM data width	N/A	00h	N/A	00h
15	Minimum clock delay, back-to-back random column addresses	1 CK cycle	01h	1 CK cycle	01h
16	Burst lengths supported	1, 2, 4, 8	0Fh	1, 2, 4, 8	0Fh
17	Number of banks on each SDRAM device	2 banks	02h	2 banks	02h
18	CAS latencies supported	2, 3	06h	2, 3	06h
19	CS latency	0	01h	0	01h
20	Write latency	0	01h	0	01h
21	SDRAM module attributes	Non-buffered/ Non-registered	00h	Non-buffered/ Non-registered	00h
22	SDRAM device attributes: general	V_{DD} tolerance = (+10%)/(−5%). Burst read/write, precharge all, auto precharge	1Eh	V_{DD} tolerance = (±10%), Burst read/write, precharge all, auto precharge	0Eh
23	Minimum clock cycle time at CL = X − 1	t_{CK} = 15 ns	F0h	t_{CK} = 18 ns	30h

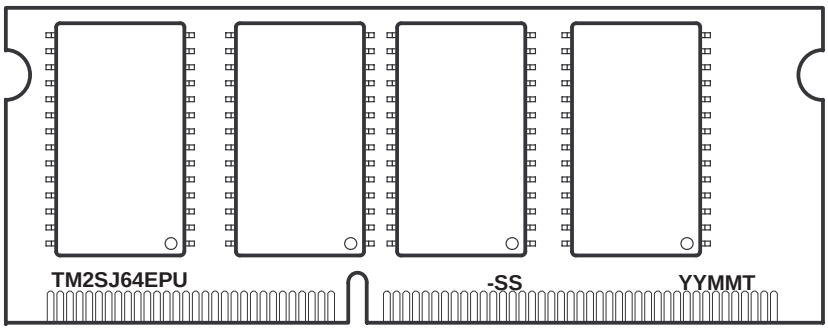
serial presence detect (continued)

Table 1. Serial Presence Detect Data (Continued)

BYTE NO.	DESCRIPTION OF FUNCTION	TM2SJ64EPU-12A		TM2SJ64EPU-12	
		ITEM	DATA	ITEM	DATA
24	Maximum data-access time from clock at CL = X − 1	t_{AC} = 9.0 ns	90h	t_{AC} = 10 ns	A0h
25	Minimum clock cycle time at CL = X − 2	N/A	00h	N/A	00h
26	Maximum data-access time from clock at CL = X − 2	N/A	00h	N/A	00h
27	Minimum row precharge time	t_{RP} = 30 ns	1Eh	t_{RP} = 36 ns	24h
28	Minimum row-active to row-active delay	t_{RRD} = 24 ns	18h	t_{RRD} = 24 ns	18h
29	Minimum $\overline{\text{RAS}}$x-to-$\overline{\text{CAS}}$x delay	t_{RCD} = 30 ns	1Eh	t_{RCD} = 30 ns	1Eh
30	Minimum $\overline{\text{RAS}}$x pulse width	t_{RAS} = 60 ns	3Ch	t_{RAS} = 72 ns	48h
31	Density of each bank on module	16M Bytes	04h	16M Bytes	04h
32	Command and address signal input setup time	t_{IS} = 3 ns	30h	t_{IS} = 3 ns	30h
33	Command and address signal input hold time	t_{IH} = 1 ns	10h	t_{IH} = 1.5 ns	15h
34	Data signal input setup time	t_{IS} = 3 ns	30h	t_{IS} = 3 ns	30h
35	Data signal input hold time	t_{IH} = 1 ns	10h	t_{IH} = 1.5 ns	15h
36−61	Superset features (may be used in the future)				
62	SPD revision	Rev. 2	02h	Rev. 2	02h
63	Checksum for byte 0−62	136	88h	228	E4h
64−71	Manufacturer's JEDEC ID code per JEP−106E	97h	9700...00h	97h	9700...00h
72	Manufacturing location†	TBD		TBD	
73−90	Manufacturer's part number†	TBD		TBD	
91	Die revision code†	TBD		TBD	
92	PCB revision code†	TBD		TBD	
93−94	Manufacturing date†	TBD		TBD	
95−98	Assembly serial number†	TBD		TBD	
99−125	Manufacturer specific data†	TBD		TBD	
126−127	Vendor specific data†	TBD		TBD	
128−166	System integrator's specific data‡	TBD		TBD	
167−255	Open				

† TBD indicates values are determined at manufacturing time and are module dependent.
‡ These TBD values are determined and programmed by the customer (optional).

device symbolization (TM2SJ64EPU)

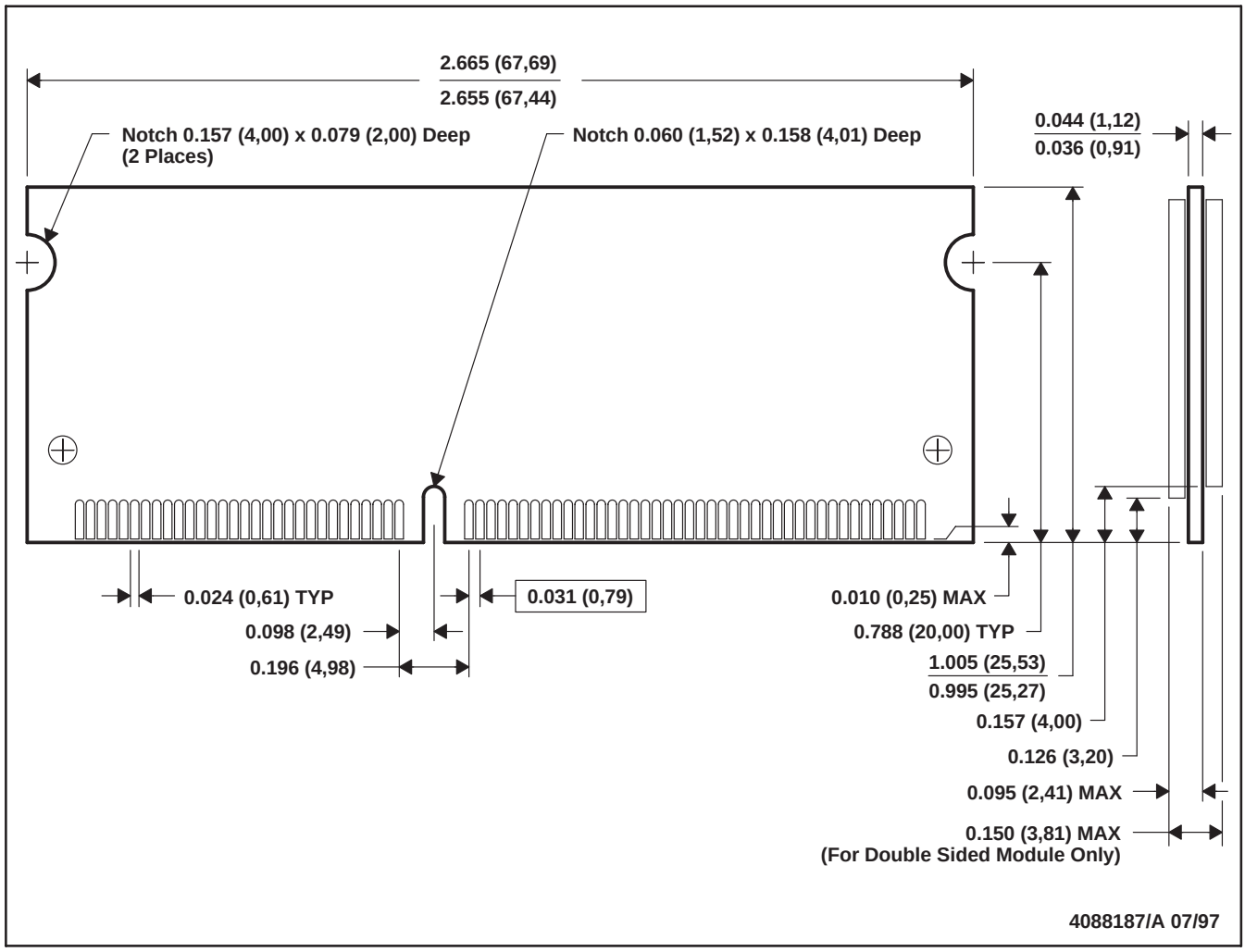


YY = Year Code
MM = Month Code
T = Assembly Site Code
-SS = Speed Code

NOTE A: Location of symbolization may vary.

MECHANICAL DATA

BDM (R-SODIMM-N144) **SMALL OUTLINE DUAL IN-LINE MEMORY MODULE**



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MO-190

- **Organization: 2 097 152 x 64 Bits**
- **Single 3.3-V Power Supply (±10% Tolerance)**
- **Designed for 66-MHz 4-Clock Systems**
- **JEDEC 144-Pin Small-Outline Dual-In-Line Memory Module (SODIMM) Without Buffer for Use With Socket**
- **Uses Eight 16M-Bit Synchronous Dynamic RAMs (SDRAMs) (2M × 8-Bit) in Plastic Thin Small-Outline Packages (TSOPs)**
- **Byte-Read/Write Capability**
- **Read Latencies 2 and 3 Supported**
- **Performance Ranges:**
- **Support Burst-Interleave and Burst-Interrupt Operations**
- **Burst Length Programmable to 1, 2, 4, and 8**
- **Two Banks for On-Chip Interleaving (Gapless Access)**
- **Ambient Temperature Range 0°C to 70°C**
- **Gold-Plated Contacts**
- **Pipeline Architecture**
- **High-Speed, Low-Noise Low-Voltage TTL (LVTTL) Interface**
- **Serial Presence Detect (SPD) Using EEPROM**

	SYNCHRONOUS CLOCK CYCLE TIME		ACCESS TIME CLOCK TO OUTPUT		REFRESH INTERVAL
	t_{CK3} (CL = 3)‡	t_{CK2} (CL = 2)	t_{AC3} (CL = 3)	t_{AC2} (CL = 2)	
'xSJ64EPU-12A†	12 ns	15 ns	9 ns	9 ns	64 ms
'xSJ64EPU-12	12 ns	18 ns	9 ns	10 ns	64 ms

† −12A speed device is supported only at −5 to 10% V_{DD}
‡ CL = CAS latency

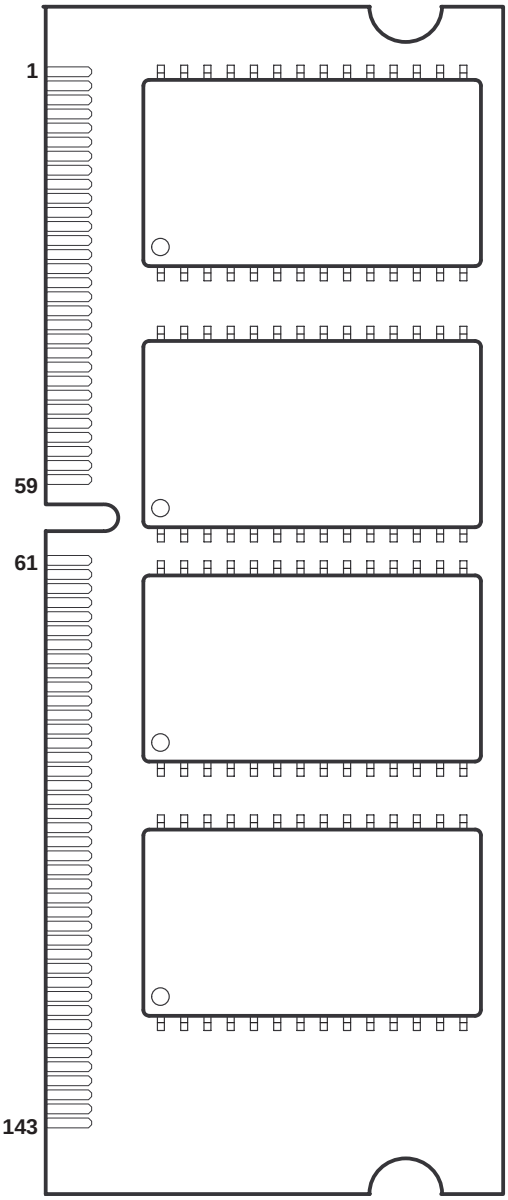
description

The TM2SJ64EPU is a 16M-byte, 144-pin small-outline dual-in-line memory module (SODIMM). The SODIMM is composed of eight TMS626812DGE, 2097152 x 8-bit SDRAMs, each in a 400-mil, 44-pin plastic thin small-outline package (TSOP) mounted on a substrate with decoupling capacitors. See the TMS626812 data sheet (literature number SMOS687).

operation

The TM2SJ64EPU operates as eight TMS626812DGE devices that are connected as shown in the TM2SJ64EPU functional block diagram.

DUAL-IN-LINE MEMORY MODULE (TOP VIEW)



TM2SJ64EPU (SIDE VIEW)

PIN NOMENCLATURE

A[0:10]	Row Address Inputs
A[0:8]	Column Address Inputs
A11/BA0, BA1	Bank-Select
$\overline{\text{CAS}}$	Column-Address Strobe
CKE[0:1]	Clock Enable
CK[0:3]	System Clock
DQ[0:63]	Data-In/Data-Out
DQMB[0:7]	Data-In/Data-Out Mask Enable
$\overline{\text{NC}}$	No Connect
$\overline{\text{RAS}}$	Row-Address Strobe
$\overline{\text{S0}}$, $\overline{\text{S1}}$	Chip-Select
SCL	SPD Clock
SDA	SPD Address/Data
V_{DD}	3.3-V Supply
V_{SS}	Ground
$\overline{\text{WE}}$	Write Enable

Pin Assignments

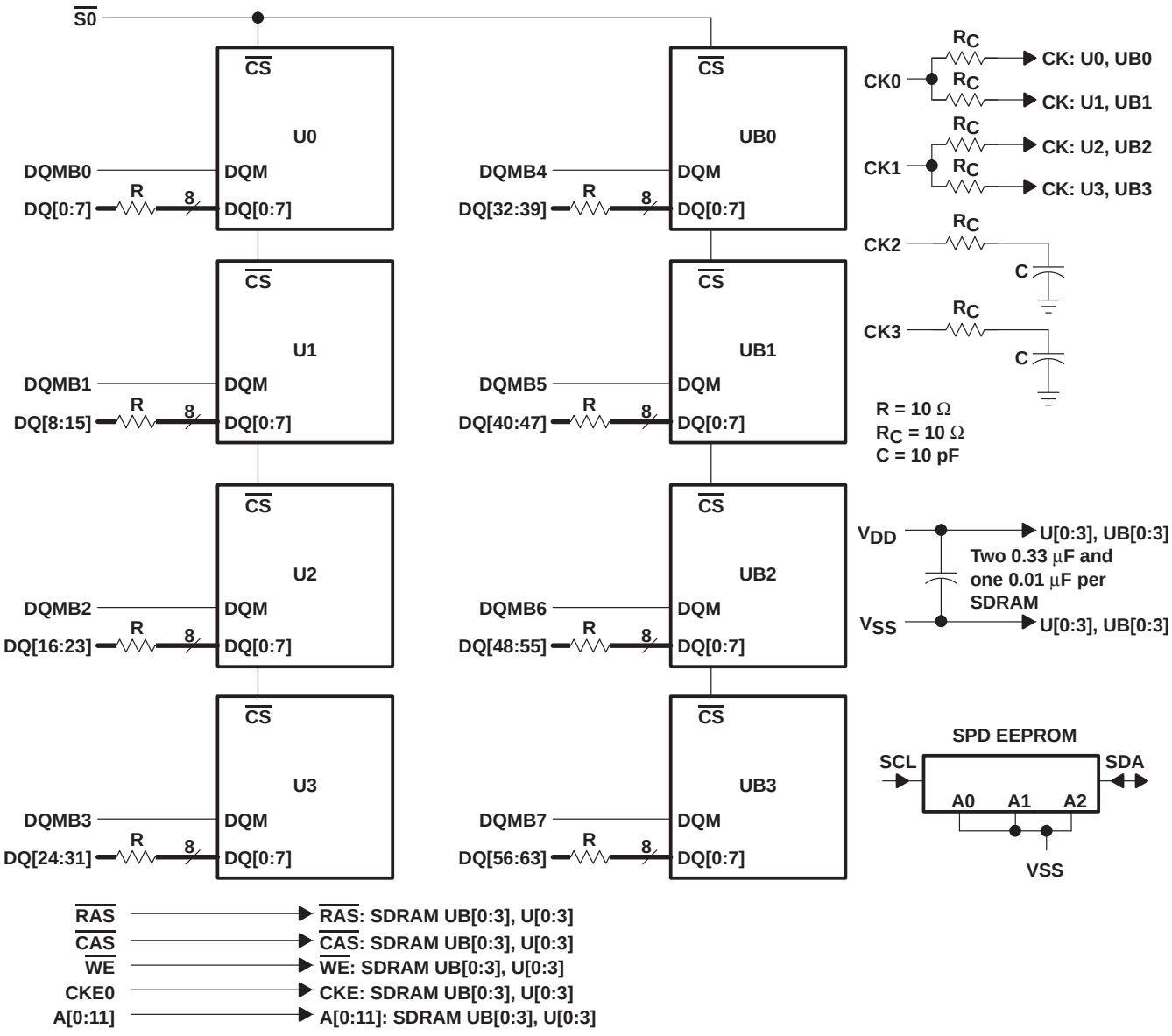
PIN NO.	PIN NAME	PIN NO.	PIN NAME	PIN NO.	PIN NAME	PIN NO.	PIN NAME
1	V_{SS}	37	DQ8	73	NC	109	A9
2	V_{SS}	38	DQ40	74	CK1	110	BA1
3	DQ0	39	DQ9	75	V_{SS}	111	A10
4	DQ32	40	DQ41	76	V_{SS}	112	A11
5	DQ1	41	DQ10	77	NC	113	V_{DD}
6	DQ33	42	DQ42	78	NC	114	V_{DD}
7	DQ2	43	DQ11	79	NC	115	DQMB2
8	DQ34	44	DQ43	80	NC	116	DQMB6
9	DQ3	45	V_{DD}	81	V_{DD}	117	DQMB3
10	DQ35	46	V_{DD}	82	V_{DD}	118	DQMB7
11	V_{DD}	47	DQ12	83	DQ16	119	V_{SS}
12	V_{DD}	48	DQ44	84	DQ48	120	V_{SS}
13	DQ4	49	DQ13	85	DQ17	121	DQ24
14	DQ36	50	DQ45	86	DQ49	122	DQ56
15	DQ5	51	DQ14	87	DQ18	123	DQ25
16	DQ37	52	DQ46	88	DQ50	124	DQ57
17	DQ6	53	DQ15	89	DQ19	125	DQ26
18	DQ38	54	DQ47	90	DQ51	126	DQ58
19	DQ7	55	V_{SS}	91	V_{SS}	127	DQ27
20	DQ39	56	V_{SS}	92	V_{SS}	128	DQ59
21	V_{SS}	57	NC	93	DQ20	129	V_{DD}
22	V_{SS}	58	NC	94	DQ52	130	V_{DD}
23	DQMB0	59	NC	95	DQ21	131	DQ28
24	DQMB4	60	NC	96	DQ53	132	DQ60
25	DQMB1	61	CK0	97	DQ22	133	DQ29
26	DQMB5	62	CKE0	98	DQ54	134	DQ61
27	V_{DD}	63	V_{DD}	99	DQ23	135	DQ30
28	V_{DD}	64	V_{DD}	100	DQ55	136	DQ62
29	A0	65	$\overline{RAS}$	101	V_{DD}	137	DQ31
30	A3	66	$\overline{CAS}$	102	V_{DD}	138	DQ63
31	A1	67	$\overline{WE}$	103	A6	139	V_{SS}
32	A4	68	CKE1	104	A7	140	V_{SS}
33	A2	69	$\overline{S0}$	105	A8	141	SDA
34	A5	70	NC	106	A11/BA0	142	SCL
35	V_{SS}	71	$\overline{S1}$	107	V_{SS}	143	V_{DD}
36	V_{SS}	72	NC	108	V_{SS}	144	V_{DD}

small-outline dual-in-line memory module and components

The small-outline dual-in-line memory module and components include:

- PC substrate: 1,10 ± 0,1 mm (0.04 inch) nominal thickness
- Bypass capacitors: Multilayer ceramic
- Contact area: Nickel plate and gold plate over copper

functional block diagram



Legend:
CS = Chip select
SPD = Serial presence detect

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
POST OFFICE BOX 1443 • HOUSTON, TEXAS 77251−1443

absolute maximum ratings over ambient temperature range (unless otherwise noted)†

Supply voltage range, V_{DD} . . . . . −0.5 V to 4.6 V
Voltage range on any pin (see Note 1) . . . . . − 0.5 V to 4.6 V
Short-circuit output current . . . . . 50 mA
Power dissipation: . . . . . 8 W
Ambient temperature range, T_A . . . . . 0°C to 70°C
Storage temperature range, T_{stg} . . . . . − 55°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to V_{SS}.

recommended operating conditions

		MIN	NOM	MAX	UNIT
V_{DD}	Supply voltage	3	3.3	3.6	V
V_{SS}	Supply voltage		0		V
V_{IH}	High-level input voltage	2		V_{DD} + 0.3	V
V_{IH-SPD}	High-level input voltage for the SPD device	2		5.5	V
V_{IL}	Low-level input voltage ‡	−0.3		0.8	V
T_A	Ambient temperature	0		70	°C

‡ V_{IL} MIN = −1.5 V ac (pulse width ≤ 5 ns)

capacitance over recommended ranges of supply voltage and ambient temperature, f = 1 MHz (see Note 2)§

PARAMETERS		TM2SJ64EPU		UNIT
		MIN	MAX	
$C_{i(CK)}$	Input capacitance, CK input		5	pF
$C_{i(AC)}$	Input capacitance, address and control inputs: A0−A11, $\overline{RAS}$x, $\overline{CAS}$x, $\overline{WE}$x		5	pF
$C_{i(CKE)}$	Input capacitance, CKE input		5	pF
C_o	Output capacitance		8	pF
$C_{i(DQMBx)}$	Input capacitance, DQMBx input		5	pF
$C_{i(Sx)}$	Input capacitance, $\overline{Sx}$ input		5	pF
$C_{i/o(SDA)}$	Input/output capacitance, SDA input		9	pF
$C_{i(SPD)}$	Input capacitance, SPD inputs (except SDA)		7	pF

§ Specifications in this table represent a single SDRAM device.

NOTE 2: V_{DD} = 3.3 V ± 0.3 V. Bias on pins under test is 0 V.

electrical characteristics over recommended ranges of supply voltage and ambient temperature (unless otherwise noted) (see Note 3)†

PARAMETER		TEST CONDITIONS		'2SJ64EPU-12A		'2SJ64EPU-12		UNIT
				MIN	MAX	MIN	MAX	
V_{OH}	High-level output voltage	I_{OH} = − 2 mA		2.4		2.4		V
V_{OL}	Low-level output voltage	I_{OL} = 2 mA			0.4		0.4	V
I_I	Input current (leakage)	0 V < V_I < V_{DD} + 0.3 V, All other pins = 0 V to V_{DD}			±10		±10	μA
I_O	Output current (leakage)	0 V < V_O < V_{DD} +0.3 V,	Output disabled		±10		±10	μA
I_{CC1}	Operating current	Burst length = 1, $t_{RC} \geq t_{RC}$ MIN, I_{OH}/I_{OL} = 0 mA, one bank activated (see Note 4)	CAS latency = 2		85		75	mA
			CAS latency = 3		95		95	mA
I_{CC2P}	Precharge standby current in power-down mode	CKE ≤ V_{IL} MAX, t_{CK} = 15 ns (see Note 5)			2		2	mA
I_{CC2PS}		CKE and CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			2		2	mA
I_{CC2N}	Precharge standby current in non-power-down mode	CKE ≥ V_{IH} MIN, t_{CK} = 15 ns (see Note 5)			30		30	mA
I_{CC2NS}		CKE ≥ V_{IH} MIN, CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			2		2	mA
I_{CC3P}	Active standby current in power-down mode	CKE ≤ V_{IL} MAX, t_{CK} = 15 ns (see Note 5)			8		8	mA
I_{CC3PS}		CKE and CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			8		8	mA
I_{CC3N}	Active standby current in non-power-down mode	CKE ≥ V_{IH} MIN, t_{CK} = 15 ns (see Note 5)			35		35	mA
I_{CC3NS}		CKE ≥ V_{IH} MIN, CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			10		10	mA
I_{CC4}	Burst current	Page burst, I_{OH}/I_{OL} = 0 mA All banks activated, n_{CCD} = one cycle (see Note 7)	CAS latency = 2		130		110	mA
			CAS latency = 3		155		155	mA
I_{CC5}	Auto-refresh current	$t_{RC} \leq t_{RC}$ MIN	CAS latency = 2		75		70	mA
			CAS latency = 3		85		85	mA
I_{CC6}	Self-refresh current	CKE ≤ V_{IL} MAX			2		2	mA

† Specifications in this table represent a single SDRAM device.

NOTES: 3. All specifications apply to the device after power-up initialization. All control and address inputs must be stable and valid.
4. Control, DQ, and address inputs change state twice during t_{RC}.
5. Control, DQ, and address inputs change state once every 30 ns.
6. Control, DQ, and address inputs do not change.
7. Control, DQ, and address inputs change once every cycle.

ac timing requirements †‡

		'2SJ64EPU-12A§		'2SJ64EPU-12		UNIT
		MIN	MAX	MIN	MAX	
t_{AC2}	Access time, CK high to data out, CAS latency = 2 (see Note 8)		9		10	ns
t_{AC3}	Access time, CK high to data out, CAS latency = 3 (see Note 8)		9		9	ns
t_{CK2}	Cycle time, CK, CAS latency = 2	15		18		ns
t_{CK3}	Cycle time, CK, CAS latency = 3	12		12		ns
t_{LZ}	Delay time, CK high to DQ in low-impedance state (see Note 9)	3		3		ns
t_{HZ}	Delay time, CK high to DQ in high-impedance state (see Note 10)		10		10	ns
t_{RAS}	Delay time, ACTV command to DEAC or DCAB command	60	100000	72	100000	ns
t_{RC}	Delay time, ACTV, MRS, REFR, or SLFR to ACTV, MRS, REFR, or SLFR command	90		108		ns
t_{RCD}	Delay time, ACTV command to READ, READ-P, WRT, or WRT-P command (see Note 11)	30		30		ns
t_{RP}	Delay time, DEAC or DCAB command to ACTV, MRS, REFR, or SLFR command	30		36		ns
t_{RRD}	Delay time, ACTV command in one bank to ACTV command in the other bank	24		24		ns
t_{RSA}	Delay time, MRS command to ACTV, MRS, REFR, or SLFR command	24		24		ns
t_{APR}	Final data out of READ-P operation to ACTV, MRS, SLFR, or REFR command	$t_{RP} - (CL - 1) * t_{CK}$				ns
t_{OH}	Hold time, CK high to data out	3		3		ns
t_{IH}	Hold time, address, control, and data input	1		1.5		ns
t_{CESP}	Power down/self-refresh exit time	10		10		ns
t_{CH}	Pulse duration, CK high	4		4		ns
t_{CL}	Pulse duration, CK low	4		4		ns
t_{IS}	Setup time, address, control, and data input	3		3		ns
t_{APW}	Final data in of WRT-P operation to ACTV, MRS, SLFR, or REFR command	60		60		ns
t_{WR}	Delay time, final data in of WRT operation to DEAC or DCAB command	15		20		ns
t_T	Transition time (see Note 12)	1	5	1	5	ns
t_{REF}	Refresh interval		64		64	ms
n_{CCD}	Delay time, READ or WRT command to an interrupting command	1		1		cycle
n_{CDD}	Delay time, CS low or high to input enabled or inhibited	0	0	0	0	cycle
n_{CLE}	Delay time, CKE high or low to CK enabled or disabled	1	1	1	1	cycle
n_{CWL}	Delay time, final data in of WRT operation to READ, READ-P, WRT, WRT-P	1		1		cycle
n_{DID}	Delay time, ENBL or MASK command to enabled or masked data in	0	0	0	0	cycle
n_{DOD}	Delay time, ENBL or MASK command to enabled or masked data out	2	2	2	2	cycle
n_{HZP2}	Delay time, DEAC or DCAB command to DQ in high-impedance state, CAS latency = 2		2		2	cycle
n_{HZP3}	Delay time, DEAC or DCAB command to DQ in high-impedance state, CAS latency = 3		3		3	cycle
n_{WCD}	Delay time, WRT command to first data in	0	0	0	0	cycle

† All references are made to the rising transition of CK unless otherwise noted.
‡ Specifications in this table represent a single SDRAM device.
§ -12A speed device is supplied only at − 5% to +10% V_{DD}

NOTES: 8. t_{AC} is referenced from the rising transition of CK that is previous to the data-out cycle. For example, the first data out t_{AC} is referenced from the rising transition of CKx that is CAS latency − one cycle after the READ command. Access time is measured at output reference level 1.4 V.
9. t_{LZ} is measured from the rising transition of CLK that is CAS latency − one cycle after the READ command.
10. t_{HZ} MAX defines the time at which the outputs are no longer driven and is not referenced to output voltage levels.
11. For read or write operations with automatic deactivate, t_{RCD} must be set to satisfy minimum t_{RAS}.
12. Transition time, t_T, is measured between V_{IH} and V_{IL}.

serial presence detect

The serial presence detect (SPD) is contained in a 2K-bit serial EEPROM located on the module. The SPD nonvolatile EEPROM contains various data such as module configuration, SDRAM organization, and timing parameters (see Table 1). Only the first 128 bytes are programmed by Texas Instruments, while the remaining 128 bytes are available for customer use. Programming is done through an IIC bus using the clock (SCL) and data (SDA) signals. All Texas Instruments modules comply with the current JEDEC SPD Standard. See the *Texas Instruments Serial Presence Detect Technical Reference* (literature number SMMU001) for further details.

Table 1 lists the functions of the TM2SJ64EPU.

Table 1. Serial Presence Detect Data

BYTE NO.	DESCRIPTION OF FUNCTION	TM2SJ64EPU-12A		TM2SJ64EPU-12	
		ITEM	DATA	ITEM	DATA
0	Defines number of bytes written into serial memory during module manufacturing	128 bytes	80h	128 bytes	80h
1	Total number of bytes of SPD memory device	256 bytes	08h	256 bytes	08h
2	Fundamental memory type (FPM, EDO, SDRAM, . . .)	SDRAM	04h	SDRAM	04h
3	Number of row addresses on this assembly	11	0Bh	11	0Bh
4	Number of column addresses on this assembly	9	09h	9	09h
5	Number of module rows on this assembly	1 bank	01h	1 bank	01h
6	Data width of this assembly	64 bits	40h	64 bits	40h
7	Data width continuation		00h		00h
8	Voltage interface standard of this assembly	LVTTL	01h	LVTTL	01h
9	SDRAM cycle time at maximum supported CAS latency (CL), CL = X	t_{CK} = 12 ns	C0h	t_{CK} = 12 ns	C0h
10	SDRAM access from clock at CL = X	t_{AC} = 9 ns	90h	t_{AC} = 9 ns	90h
11	SODIMM configuration type (non-parity, parity, error-correcting code [ECC])	Non-Parity	00h	Non-Parity	00h
12	Refresh rate/type	15.6 µs/ self-refresh	80h	15.6 µs/ self-refresh	80h
13	SDRAM width, primary DRAM	x8	08h	x8	08h
14	Error-checking SDRAM data width	N/A	00h	N/A	00h
15	Minimum clock delay, back-to-back random column addresses	1 CK cycle	01h	1 CK cycle	01h
16	Burst lengths supported	1, 2, 4, 8	0Fh	1, 2, 4, 8	0Fh
17	Number of banks on each SDRAM device	2 banks	02h	2 banks	02h
18	CAS latencies supported	2, 3	06h	2, 3	06h
19	CS latency	0	01h	0	01h
20	Write latency	0	01h	0	01h
21	SDRAM module attributes	Non-buffered/ Non-registered	00h	Non-buffered/ Non-registered	00h
22	SDRAM device attributes: general	V_{DD} tolerance = (+10%)/(−5%). Burst read/write, precharge all, auto precharge	1Eh	V_{DD} tolerance = (±10%), Burst read/write, precharge all, auto precharge	0Eh
23	Minimum clock cycle time at CL = X − 1	t_{CK} = 15 ns	F0h	t_{CK} = 18 ns	30h

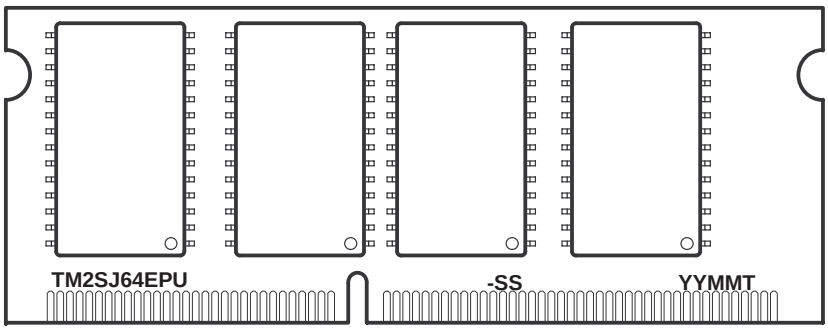
serial presence detect (continued)

Table 1. Serial Presence Detect Data (Continued)

BYTE NO.	DESCRIPTION OF FUNCTION	TM2SJ64EPU-12A		TM2SJ64EPU-12	
		ITEM	DATA	ITEM	DATA
24	Maximum data-access time from clock at CL = X − 1	t_{AC} = 9.0 ns	90h	t_{AC} = 10 ns	A0h
25	Minimum clock cycle time at CL = X − 2	N/A	00h	N/A	00h
26	Maximum data-access time from clock at CL = X − 2	N/A	00h	N/A	00h
27	Minimum row precharge time	t_{RP} = 30 ns	1Eh	t_{RP} = 36 ns	24h
28	Minimum row-active to row-active delay	t_{RRD} = 24 ns	18h	t_{RRD} = 24 ns	18h
29	Minimum $\overline{\text{RAS}}$x-to-$\overline{\text{CAS}}$x delay	t_{RCD} = 30 ns	1Eh	t_{RCD} = 30 ns	1Eh
30	Minimum $\overline{\text{RAS}}$x pulse width	t_{RAS} = 60 ns	3Ch	t_{RAS} = 72 ns	48h
31	Density of each bank on module	16M Bytes	04h	16M Bytes	04h
32	Command and address signal input setup time	t_{IS} = 3 ns	30h	t_{IS} = 3 ns	30h
33	Command and address signal input hold time	t_{IH} = 1 ns	10h	t_{IH} = 1.5 ns	15h
34	Data signal input setup time	t_{IS} = 3 ns	30h	t_{IS} = 3 ns	30h
35	Data signal input hold time	t_{IH} = 1 ns	10h	t_{IH} = 1.5 ns	15h
36−61	Superset features (may be used in the future)				
62	SPD revision	Rev. 2	02h	Rev. 2	02h
63	Checksum for byte 0−62	136	88h	228	E4h
64−71	Manufacturer's JEDEC ID code per JEP−106E	97h	9700...00h	97h	9700...00h
72	Manufacturing location†	TBD		TBD	
73−90	Manufacturer's part number†	TBD		TBD	
91	Die revision code†	TBD		TBD	
92	PCB revision code†	TBD		TBD	
93−94	Manufacturing date†	TBD		TBD	
95−98	Assembly serial number†	TBD		TBD	
99−125	Manufacturer specific data†	TBD		TBD	
126−127	Vendor specific data†	TBD		TBD	
128−166	System integrator's specific data‡	TBD		TBD	
167−255	Open				

† TBD indicates values are determined at manufacturing time and are module dependent.
‡ These TBD values are determined and programmed by the customer (optional).

device symbolization (TM2SJ64EPU)

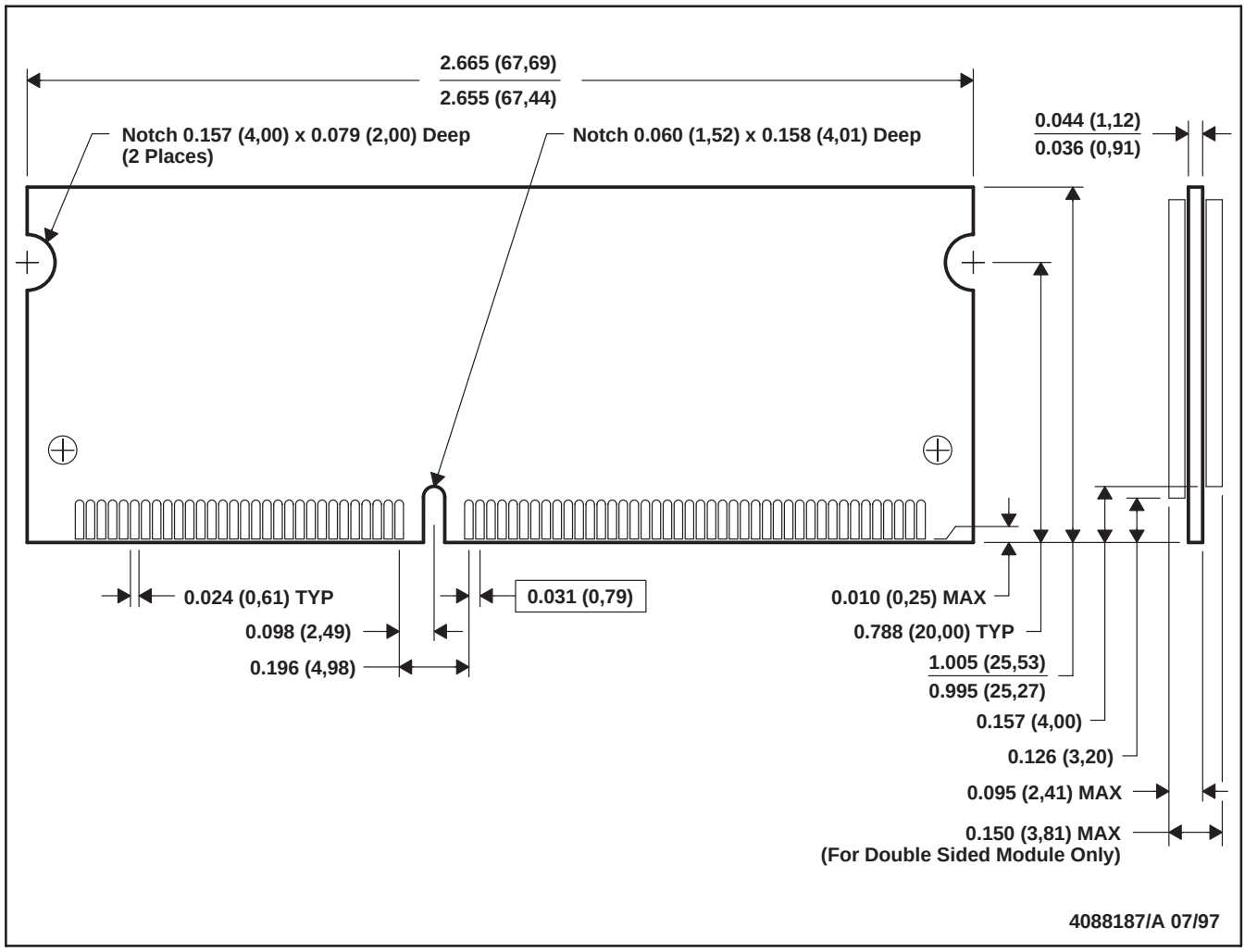


YY = Year Code
MM = Month Code
T = Assembly Site Code
-SS = Speed Code

NOTE A: Location of symbolization may vary.

MECHANICAL DATA

BDM (R-SODIMM-N144) **SMALL OUTLINE DUAL IN-LINE MEMORY MODULE**



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MO-190

- **Organization: 2 097 152 x 64 Bits**
- **Single 3.3-V Power Supply (±10% Tolerance)**
- **Designed for 66-MHz 4-Clock Systems**
- **JEDEC 144-Pin Small-Outline Dual-In-Line Memory Module (SODIMM) Without Buffer for Use With Socket**
- **Uses Eight 16M-Bit Synchronous Dynamic RAMs (SDRAMs) (2M × 8-Bit) in Plastic Thin Small-Outline Packages (TSOPs)**
- **Byte-Read/Write Capability**
- **Read Latencies 2 and 3 Supported**
- **Performance Ranges:**
- **Support Burst-Interleave and Burst-Interrupt Operations**
- **Burst Length Programmable to 1, 2, 4, and 8**
- **Two Banks for On-Chip Interleaving (Gapless Access)**
- **Ambient Temperature Range 0°C to 70°C**
- **Gold-Plated Contacts**
- **Pipeline Architecture**
- **High-Speed, Low-Noise Low-Voltage TTL (LVTTL) Interface**
- **Serial Presence Detect (SPD) Using EEPROM**

	SYNCHRONOUS CLOCK CYCLE TIME		ACCESS TIME CLOCK TO OUTPUT		REFRESH INTERVAL
	t_{CK3} (CL = 3)‡	t_{CK2} (CL = 2)	t_{AC3} (CL = 3)	t_{AC2} (CL = 2)	
'xSJ64EPU-12A†	12 ns	15 ns	9 ns	9 ns	64 ms
'xSJ64EPU-12	12 ns	18 ns	9 ns	10 ns	64 ms

† −12A speed device is supported only at −5 to 10% V_{DD}
‡ CL = CAS latency

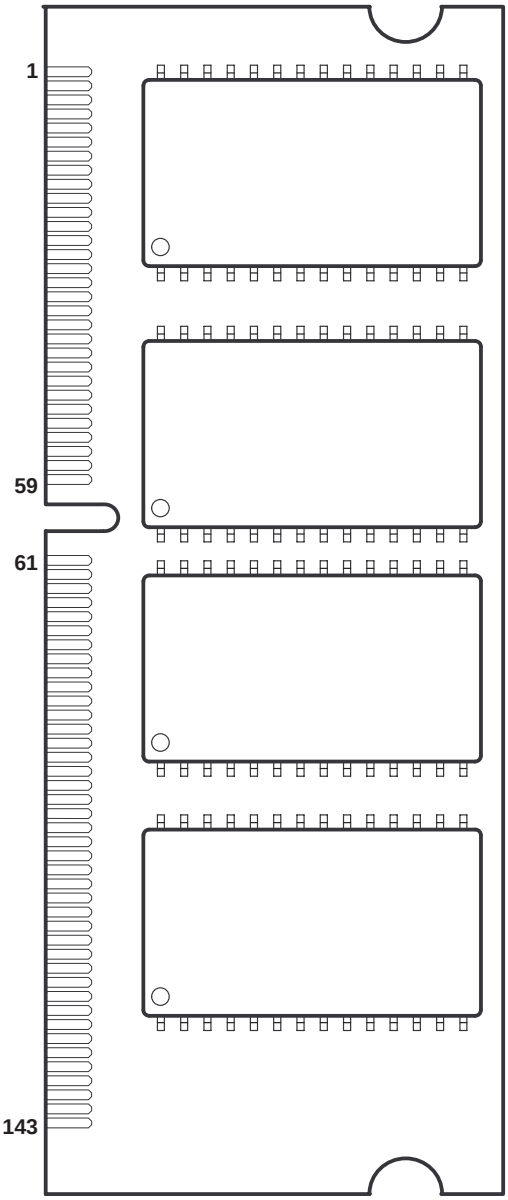
description

The TM2SJ64EPU is a 16M-byte, 144-pin small-outline dual-in-line memory module (SODIMM). The SODIMM is composed of eight TMS626812DGE, 2097152 x 8-bit SDRAMs, each in a 400-mil, 44-pin plastic thin small-outline package (TSOP) mounted on a substrate with decoupling capacitors. See the TMS626812 data sheet (literature number SMOS687).

operation

The TM2SJ64EPU operates as eight TMS626812DGE devices that are connected as shown in the TM2SJ64EPU functional block diagram.

DUAL-IN-LINE MEMORY MODULE (TOP VIEW)



TM2SJ64EPU (SIDE VIEW)

PIN NOMENCLATURE

A[0:10]	Row Address Inputs
A[0:8]	Column Address Inputs
A11/BA0, BA1	Bank-Select
$\overline{\text{CAS}}$	Column-Address Strobe
CKE[0:1]	Clock Enable
CK[0:3]	System Clock
DQ[0:63]	Data-In/Data-Out
DQMB[0:7]	Data-In/Data-Out Mask Enable
$\overline{\text{NC}}$	No Connect
$\overline{\text{RAS}}$	Row-Address Strobe
$\overline{\text{S0}}$, $\overline{\text{S1}}$	Chip-Select
SCL	SPD Clock
SDA	SPD Address/Data
V_{DD}	3.3-V Supply
V_{SS}	Ground
$\overline{\text{WE}}$	Write Enable

Pin Assignments

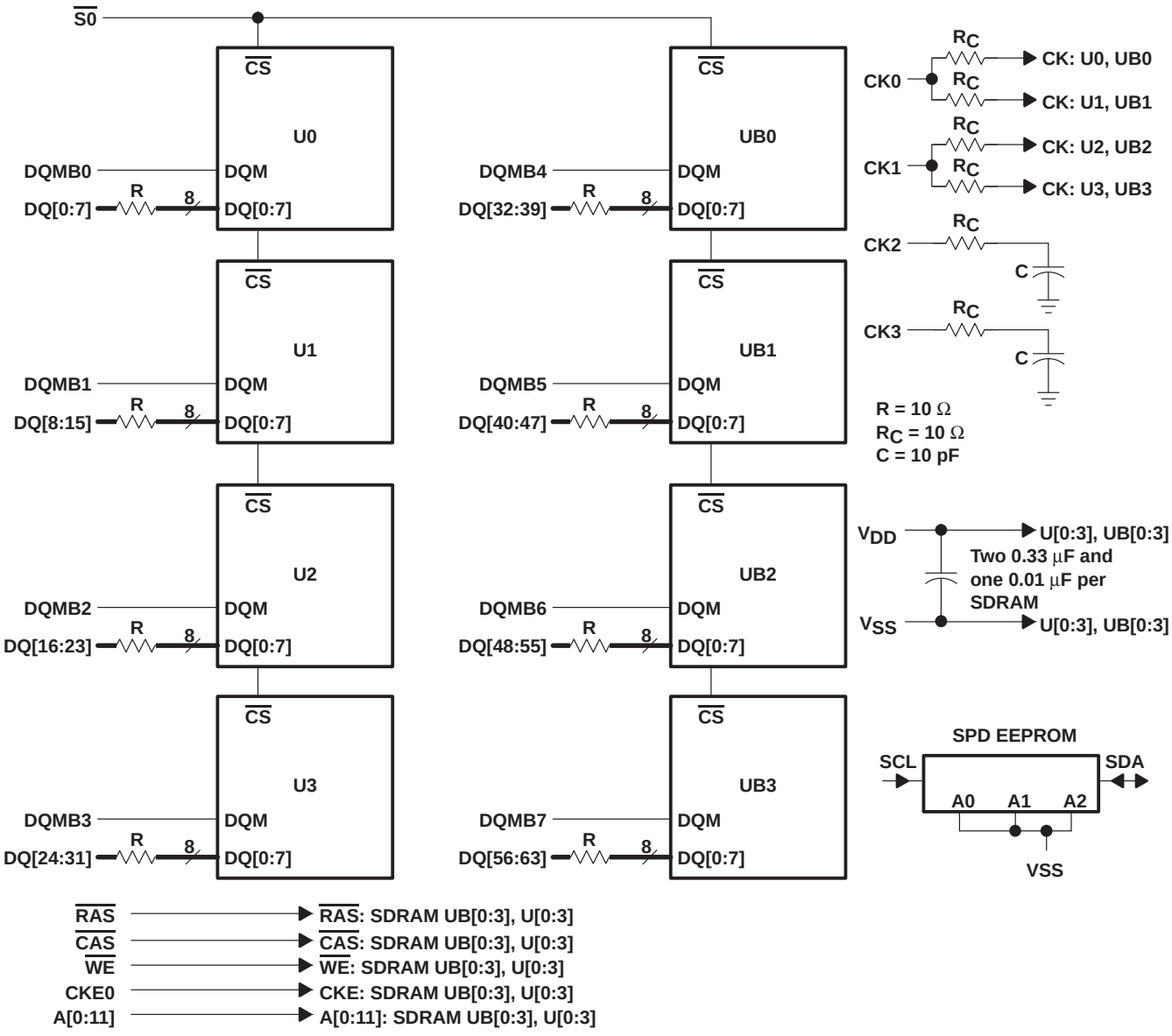
PIN NO.	PIN NAME	PIN NO.	PIN NAME	PIN NO.	PIN NAME	PIN NO.	PIN NAME
1	V_{SS}	37	DQ8	73	NC	109	A9
2	V_{SS}	38	DQ40	74	CK1	110	BA1
3	DQ0	39	DQ9	75	V_{SS}	111	A10
4	DQ32	40	DQ41	76	V_{SS}	112	A11
5	DQ1	41	DQ10	77	NC	113	V_{DD}
6	DQ33	42	DQ42	78	NC	114	V_{DD}
7	DQ2	43	DQ11	79	NC	115	DQMB2
8	DQ34	44	DQ43	80	NC	116	DQMB6
9	DQ3	45	V_{DD}	81	V_{DD}	117	DQMB3
10	DQ35	46	V_{DD}	82	V_{DD}	118	DQMB7
11	V_{DD}	47	DQ12	83	DQ16	119	V_{SS}
12	V_{DD}	48	DQ44	84	DQ48	120	V_{SS}
13	DQ4	49	DQ13	85	DQ17	121	DQ24
14	DQ36	50	DQ45	86	DQ49	122	DQ56
15	DQ5	51	DQ14	87	DQ18	123	DQ25
16	DQ37	52	DQ46	88	DQ50	124	DQ57
17	DQ6	53	DQ15	89	DQ19	125	DQ26
18	DQ38	54	DQ47	90	DQ51	126	DQ58
19	DQ7	55	V_{SS}	91	V_{SS}	127	DQ27
20	DQ39	56	V_{SS}	92	V_{SS}	128	DQ59
21	V_{SS}	57	NC	93	DQ20	129	V_{DD}
22	V_{SS}	58	NC	94	DQ52	130	V_{DD}
23	DQMB0	59	NC	95	DQ21	131	DQ28
24	DQMB4	60	NC	96	DQ53	132	DQ60
25	DQMB1	61	CK0	97	DQ22	133	DQ29
26	DQMB5	62	CKE0	98	DQ54	134	DQ61
27	V_{DD}	63	V_{DD}	99	DQ23	135	DQ30
28	V_{DD}	64	V_{DD}	100	DQ55	136	DQ62
29	A0	65	$\overline{RAS}$	101	V_{DD}	137	DQ31
30	A3	66	$\overline{CAS}$	102	V_{DD}	138	DQ63
31	A1	67	$\overline{WE}$	103	A6	139	V_{SS}
32	A4	68	CKE1	104	A7	140	V_{SS}
33	A2	69	$\overline{S0}$	105	A8	141	SDA
34	A5	70	NC	106	A11/BA0	142	SCL
35	V_{SS}	71	$\overline{S1}$	107	V_{SS}	143	V_{DD}
36	V_{SS}	72	NC	108	V_{SS}	144	V_{DD}

small-outline dual-in-line memory module and components

The small-outline dual-in-line memory module and components include:

- PC substrate: 1,10 ± 0,1 mm (0.04 inch) nominal thickness
- Bypass capacitors: Multilayer ceramic
- Contact area: Nickel plate and gold plate over copper

functional block diagram



Legend:
CS = Chip select
SPD = Serial presence detect

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
POST OFFICE BOX 1443 • HOUSTON, TEXAS 77251−1443

absolute maximum ratings over ambient temperature range (unless otherwise noted)†

Supply voltage range, V_{DD} . . . . . −0.5 V to 4.6 V
Voltage range on any pin (see Note 1) . . . . . − 0.5 V to 4.6 V
Short-circuit output current . . . . . 50 mA
Power dissipation: . . . . . 8 W
Ambient temperature range, T_A . . . . . 0°C to 70°C
Storage temperature range, T_{stg} . . . . . − 55°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to V_{SS}.

recommended operating conditions

		MIN	NOM	MAX	UNIT
V_{DD}	Supply voltage	3	3.3	3.6	V
V_{SS}	Supply voltage		0		V
V_{IH}	High-level input voltage	2		V_{DD} + 0.3	V
V_{IH-SPD}	High-level input voltage for the SPD device	2		5.5	V
V_{IL}	Low-level input voltage ‡	−0.3		0.8	V
T_A	Ambient temperature	0		70	°C

‡ V_{IL} MIN = −1.5 V ac (pulse width ≤ 5 ns)

capacitance over recommended ranges of supply voltage and ambient temperature, f = 1 MHz (see Note 2)§

PARAMETERS		TM2SJ64EPU		UNIT
		MIN	MAX	
$C_{i(CK)}$	Input capacitance, CK input		5	pF
$C_{i(AC)}$	Input capacitance, address and control inputs: A0−A11, $\overline{RAS}$x, $\overline{CAS}$x, $\overline{WE}$x		5	pF
$C_{i(CKE)}$	Input capacitance, CKE input		5	pF
C_o	Output capacitance		8	pF
$C_{i(DQMBx)}$	Input capacitance, DQMBx input		5	pF
$C_{i(Sx)}$	Input capacitance, $\overline{Sx}$ input		5	pF
$C_{i/o(SDA)}$	Input/output capacitance, SDA input		9	pF
$C_{i(SPD)}$	Input capacitance, SPD inputs (except SDA)		7	pF

§ Specifications in this table represent a single SDRAM device.

NOTE 2: V_{DD} = 3.3 V ± 0.3 V. Bias on pins under test is 0 V.

electrical characteristics over recommended ranges of supply voltage and ambient temperature (unless otherwise noted) (see Note 3)†

PARAMETER		TEST CONDITIONS		'2SJ64EPU-12A		'2SJ64EPU-12		UNIT
				MIN	MAX	MIN	MAX	
V_{OH}	High-level output voltage	I_{OH} = − 2 mA		2.4		2.4		V
V_{OL}	Low-level output voltage	I_{OL} = 2 mA			0.4		0.4	V
I_I	Input current (leakage)	0 V < V_I < V_{DD} + 0.3 V, All other pins = 0 V to V_{DD}			±10		±10	µA
I_O	Output current (leakage)	0 V < V_O < V_{DD} +0.3 V,	Output disabled		±10		±10	µA
I_{CC1}	Operating current	Burst length = 1, $t_{RC} \geq t_{RC}$ MIN, I_{OH}/I_{OL} = 0 mA, one bank activated (see Note 4)	CAS latency = 2		85		75	mA
			CAS latency = 3		95		95	mA
I_{CC2P}	Precharge standby current in power-down mode	CKE ≤ V_{IL} MAX, t_{CK} = 15 ns (see Note 5)			2		2	mA
I_{CC2PS}		CKE and CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			2		2	mA
I_{CC2N}	Precharge standby current in non-power-down mode	CKE ≥ V_{IH} MIN, t_{CK} = 15 ns (see Note 5)			30		30	mA
I_{CC2NS}		CKE ≥ V_{IH} MIN, CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			2		2	mA
I_{CC3P}	Active standby current in power-down mode	CKE ≤ V_{IL} MAX, t_{CK} = 15 ns (see Note 5)			8		8	mA
I_{CC3PS}		CKE and CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			8		8	mA
I_{CC3N}	Active standby current in non-power-down mode	CKE ≥ V_{IH} MIN, t_{CK} = 15 ns (see Note 5)			35		35	mA
I_{CC3NS}		CKE ≥ V_{IH} MIN, CK ≤ V_{IL} MAX, t_{CK} = ∞ (see Note 6)			10		10	mA
I_{CC4}	Burst current	Page burst, I_{OH}/I_{OL} = 0 mA All banks activated, n_{CCD} = one cycle (see Note 7)	CAS latency = 2		130		110	mA
			CAS latency = 3		155		155	mA
I_{CC5}	Auto-refresh current	$t_{RC} \leq t_{RC}$ MIN	CAS latency = 2		75		70	mA
			CAS latency = 3		85		85	mA
I_{CC6}	Self-refresh current	CKE ≤ V_{IL} MAX			2		2	mA

† Specifications in this table represent a single SDRAM device.

NOTES: 3. All specifications apply to the device after power-up initialization. All control and address inputs must be stable and valid.
4. Control, DQ, and address inputs change state twice during t_{RC}.
5. Control, DQ, and address inputs change state once every 30 ns.
6. Control, DQ, and address inputs do not change.
7. Control, DQ, and address inputs change once every cycle.

ac timing requirements †‡

		'2SJ64EPU-12A§		'2SJ64EPU-12		UNIT
		MIN	MAX	MIN	MAX	
t_{AC2}	Access time, CK high to data out, CAS latency = 2 (see Note 8)		9		10	ns
t_{AC3}	Access time, CK high to data out, CAS latency = 3 (see Note 8)		9		9	ns
t_{CK2}	Cycle time, CK, CAS latency = 2	15		18		ns
t_{CK3}	Cycle time, CK, CAS latency = 3	12		12		ns
t_{LZ}	Delay time, CK high to DQ in low-impedance state (see Note 9)	3		3		ns
t_{HZ}	Delay time, CK high to DQ in high-impedance state (see Note 10)		10		10	ns
t_{RAS}	Delay time, ACTV command to DEAC or DCAB command	60	100000	72	100000	ns
t_{RC}	Delay time, ACTV, MRS, REFR, or SLFR to ACTV, MRS, REFR, or SLFR command	90		108		ns
t_{RCD}	Delay time, ACTV command to READ, READ-P, WRT, or WRT-P command (see Note 11)	30		30		ns
t_{RP}	Delay time, DEAC or DCAB command to ACTV, MRS, REFR, or SLFR command	30		36		ns
t_{RRD}	Delay time, ACTV command in one bank to ACTV command in the other bank	24		24		ns
t_{RSA}	Delay time, MRS command to ACTV, MRS, REFR, or SLFR command	24		24		ns
t_{APR}	Final data out of READ-P operation to ACTV, MRS, SLFR, or REFR command	$t_{RP} - (CL - 1) * t_{CK}$				ns
t_{OH}	Hold time, CK high to data out	3		3		ns
t_{IH}	Hold time, address, control, and data input	1		1.5		ns
t_{CESP}	Power down/self-refresh exit time	10		10		ns
t_{CH}	Pulse duration, CK high	4		4		ns
t_{CL}	Pulse duration, CK low	4		4		ns
t_{IS}	Setup time, address, control, and data input	3		3		ns
t_{APW}	Final data in of WRT-P operation to ACTV, MRS, SLFR, or REFR command	60		60		ns
t_{WR}	Delay time, final data in of WRT operation to DEAC or DCAB command	15		20		ns
t_T	Transition time (see Note 12)	1	5	1	5	ns
t_{REF}	Refresh interval		64		64	ms
n_{CCD}	Delay time, READ or WRT command to an interrupting command	1		1		cycle
n_{CDD}	Delay time, CS low or high to input enabled or inhibited	0	0	0	0	cycle
n_{CLE}	Delay time, CKE high or low to CK enabled or disabled	1	1	1	1	cycle
n_{CWL}	Delay time, final data in of WRT operation to READ, READ-P, WRT, WRT-P	1		1		cycle
n_{DID}	Delay time, ENBL or MASK command to enabled or masked data in	0	0	0	0	cycle
n_{DOD}	Delay time, ENBL or MASK command to enabled or masked data out	2	2	2	2	cycle
n_{HZP2}	Delay time, DEAC or DCAB command to DQ in high-impedance state, CAS latency = 2		2		2	cycle
n_{HZP3}	Delay time, DEAC or DCAB command to DQ in high-impedance state, CAS latency = 3		3		3	cycle
n_{WCD}	Delay time, WRT command to first data in	0	0	0	0	cycle

† All references are made to the rising transition of CK unless otherwise noted.
‡ Specifications in this table represent a single SDRAM device.
§ -12A speed device is supplied only at − 5% to +10% V_{DD}

NOTES: 8. t_{AC} is referenced from the rising transition of CK that is previous to the data-out cycle. For example, the first data out t_{AC} is referenced from the rising transition of CKx that is CAS latency − one cycle after the READ command. Access time is measured at output reference level 1.4 V.
9. t_{LZ} is measured from the rising transition of CLK that is CAS latency − one cycle after the READ command.
10. t_{HZ} MAX defines the time at which the outputs are no longer driven and is not referenced to output voltage levels.
11. For read or write operations with automatic deactivate, t_{RCD} must be set to satisfy minimum t_{RAS}.
12. Transition time, t_T, is measured between V_{IH} and V_{IL}.

serial presence detect

The serial presence detect (SPD) is contained in a 2K-bit serial EEPROM located on the module. The SPD nonvolatile EEPROM contains various data such as module configuration, SDRAM organization, and timing parameters (see Table 1). Only the first 128 bytes are programmed by Texas Instruments, while the remaining 128 bytes are available for customer use. Programming is done through an IIC bus using the clock (SCL) and data (SDA) signals. All Texas Instruments modules comply with the current JEDEC SPD Standard. See the *Texas Instruments Serial Presence Detect Technical Reference* (literature number SMMU001) for further details.

Table 1 lists the functions of the TM2SJ64EPU.

Table 1. Serial Presence Detect Data

BYTE NO.	DESCRIPTION OF FUNCTION	TM2SJ64EPU-12A		TM2SJ64EPU-12	
		ITEM	DATA	ITEM	DATA
0	Defines number of bytes written into serial memory during module manufacturing	128 bytes	80h	128 bytes	80h
1	Total number of bytes of SPD memory device	256 bytes	08h	256 bytes	08h
2	Fundamental memory type (FPM, EDO, SDRAM, . . .)	SDRAM	04h	SDRAM	04h
3	Number of row addresses on this assembly	11	0Bh	11	0Bh
4	Number of column addresses on this assembly	9	09h	9	09h
5	Number of module rows on this assembly	1 bank	01h	1 bank	01h
6	Data width of this assembly	64 bits	40h	64 bits	40h
7	Data width continuation		00h		00h
8	Voltage interface standard of this assembly	LVTTL	01h	LVTTL	01h
9	SDRAM cycle time at maximum supported CAS latency (CL), CL = X	t_{CK} = 12 ns	C0h	t_{CK} = 12 ns	C0h
10	SDRAM access from clock at CL = X	t_{AC} = 9 ns	90h	t_{AC} = 9 ns	90h
11	SODIMM configuration type (non-parity, parity, error-correcting code [ECC])	Non-Parity	00h	Non-Parity	00h
12	Refresh rate/type	15.6 µs/ self-refresh	80h	15.6 µs/ self-refresh	80h
13	SDRAM width, primary DRAM	x8	08h	x8	08h
14	Error-checking SDRAM data width	N/A	00h	N/A	00h
15	Minimum clock delay, back-to-back random column addresses	1 CK cycle	01h	1 CK cycle	01h
16	Burst lengths supported	1, 2, 4, 8	0Fh	1, 2, 4, 8	0Fh
17	Number of banks on each SDRAM device	2 banks	02h	2 banks	02h
18	CAS latencies supported	2, 3	06h	2, 3	06h
19	CS latency	0	01h	0	01h
20	Write latency	0	01h	0	01h
21	SDRAM module attributes	Non-buffered/ Non-registered	00h	Non-buffered/ Non-registered	00h
22	SDRAM device attributes: general	V_{DD} tolerance = (+10%)/(−5%). Burst read/write, precharge all, auto precharge	1Eh	V_{DD} tolerance = (±10%), Burst read/write, precharge all, auto precharge	0Eh
23	Minimum clock cycle time at CL = X − 1	t_{CK} = 15 ns	F0h	t_{CK} = 18 ns	30h

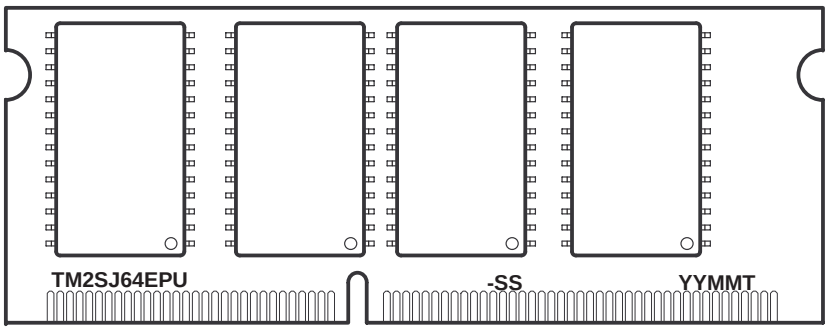
serial presence detect (continued)

Table 1. Serial Presence Detect Data (Continued)

BYTE NO.	DESCRIPTION OF FUNCTION	TM2SJ64EPU-12A		TM2SJ64EPU-12	
		ITEM	DATA	ITEM	DATA
24	Maximum data-access time from clock at CL = X − 1	t_{AC} = 9.0 ns	90h	t_{AC} = 10 ns	A0h
25	Minimum clock cycle time at CL = X − 2	N/A	00h	N/A	00h
26	Maximum data-access time from clock at CL = X − 2	N/A	00h	N/A	00h
27	Minimum row precharge time	t_{RP} = 30 ns	1Eh	t_{RP} = 36 ns	24h
28	Minimum row-active to row-active delay	t_{RRD} = 24 ns	18h	t_{RRD} = 24 ns	18h
29	Minimum $\overline{RAS}$x-to-$\overline{CAS}$x delay	t_{RCD} = 30 ns	1Eh	t_{RCD} = 30 ns	1Eh
30	Minimum $\overline{RAS}$x pulse width	t_{RAS} = 60 ns	3Ch	t_{RAS} = 72 ns	48h
31	Density of each bank on module	16M Bytes	04h	16M Bytes	04h
32	Command and address signal input setup time	t_{IS} = 3 ns	30h	t_{IS} = 3 ns	30h
33	Command and address signal input hold time	t_{IH} = 1 ns	10h	t_{IH} = 1.5 ns	15h
34	Data signal input setup time	t_{IS} = 3 ns	30h	t_{IS} = 3 ns	30h
35	Data signal input hold time	t_{IH} = 1 ns	10h	t_{IH} = 1.5 ns	15h
36−61	Superset features (may be used in the future)				
62	SPD revision	Rev. 2	02h	Rev. 2	02h
63	Checksum for byte 0−62	136	88h	228	E4h
64−71	Manufacturer's JEDEC ID code per JEP−106E	97h	9700...00h	97h	9700...00h
72	Manufacturing location†	TBD		TBD	
73−90	Manufacturer's part number†	TBD		TBD	
91	Die revision code†	TBD		TBD	
92	PCB revision code†	TBD		TBD	
93−94	Manufacturing date†	TBD		TBD	
95−98	Assembly serial number†	TBD		TBD	
99−125	Manufacturer specific data†	TBD		TBD	
126−127	Vendor specific data†	TBD		TBD	
128−166	System integrator's specific data‡	TBD		TBD	
167−255	Open				

† TBD indicates values are determined at manufacturing time and are module dependent.
‡ These TBD values are determined and programmed by the customer (optional).

device symbolization (TM2SJ64EPU)

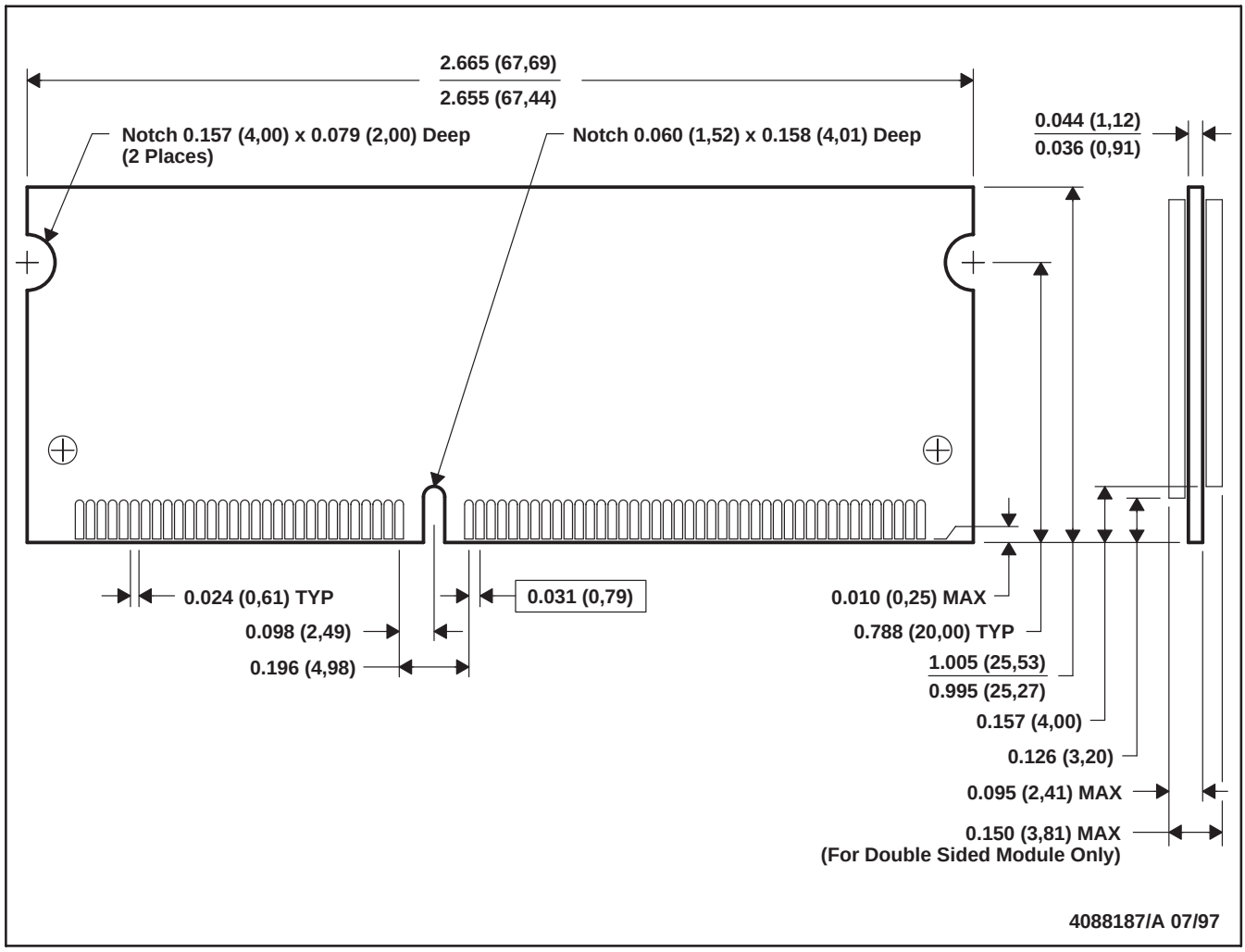


YY = Year Code
MM = Month Code
T = Assembly Site Code
-SS = Speed Code

NOTE A: Location of symbolization may vary.

MECHANICAL DATA

BDM (R-SODIMM-N144) **SMALL OUTLINE DUAL IN-LINE MEMORY MODULE**



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MO-190

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Clocks and Timers	www.ti.com/clocks	Digital Control	www.ti.com/digitalcontrol
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265