National Semiconductor

July 1988

NM1624/NM1625
16,384 x 4-Bit Static RAM

General Description

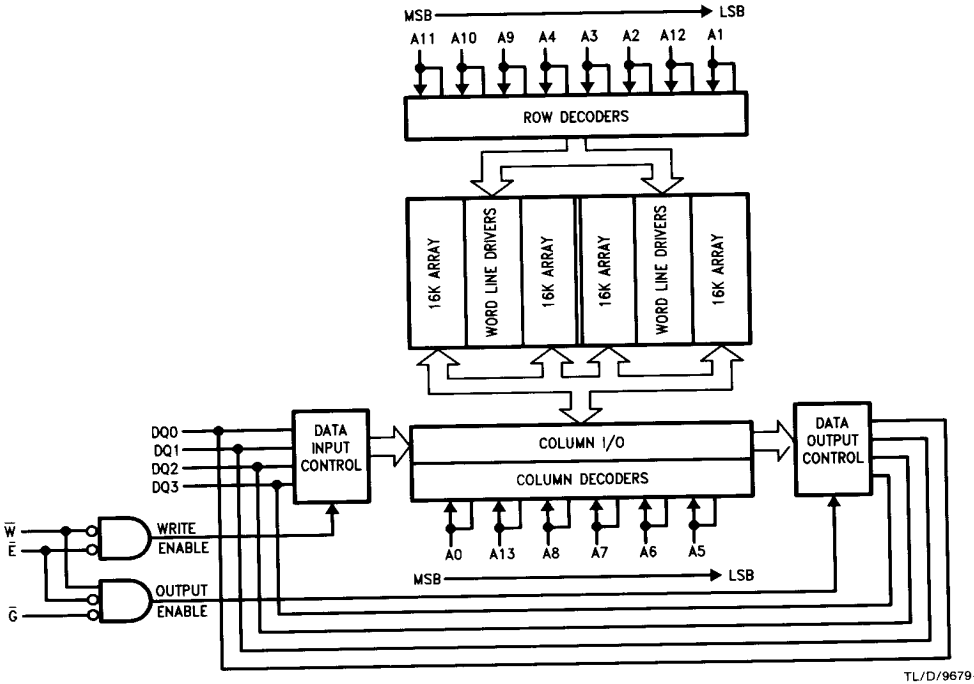
The NM1624/NM1625 are 65,536-bit fully-static, asynchronous, random access memories organized as 16,384 words by 4-bits per word. The NM1624/NM1625 are based on an advanced, isoplanar, oxide-isolation CMOS process. The process utilizes fully-implanted CMOS technology with sub-2 micron design rules and tantalum silicide gate electrodes for high performance. The combination of this high-performance technology, and speed-optimized circuitry results in a very high-speed memory device.

The NM1625 is identical to the NM1624 with the additional feature of power-down for low power battery back-up applications.

Features

- Output enable access times: 10 ns/12 ns/15 ns
- Fast address access times: 25 ns/30 ns/35 ns (maximum)
- Enable read access faster than address access
- Minimum write cycle time, including moderate system timing skews, equal to minimum read cycle time
- No internal clocks—high speed achieved without address transition detection circuitry
- All inputs and outputs directly TTL compatible
- Common I/O (TRI-STATE® output)
- Available in 24-pin DIP, PDIP, or 28-pin LCC
- Low power dissipation (data retention NM1625)
  I_{CCDR} = 35 μA max (V_{DR} = 2.0V),
  I_{CCDR} = 50 μA max (V_{DR} = 3.0V)
- Data retention supply voltage NM1625: 2.0V to 5.5V

Functional Block Diagram



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RRD-B20M88/Printed in U. S. A.

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Voltage on Any Input or Output Pin with Respect to V_{SS}	$-2.0V$ to $V_{CC} + 2V$
Storage Temperature	$-65°C$ to $+150°C$
Operating Temperature	$0°C$ to $+70°C$
Power Dissipation	1.0W
Continuous Output Current per Output	25 mA
Average Input or Output Current (Averaged over Any 1 μs Time Interval)	25 mA

Note: *Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

Recommended Operating Conditions $T_A = 0°C$ to $+70°C$

	Min	Max	Units
Input HIGH Voltage (V_{IH})	2.2	$V_{CC} + 0.5$	V
Input LOW Voltage (V_{IL})	-1*	0.8	V

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

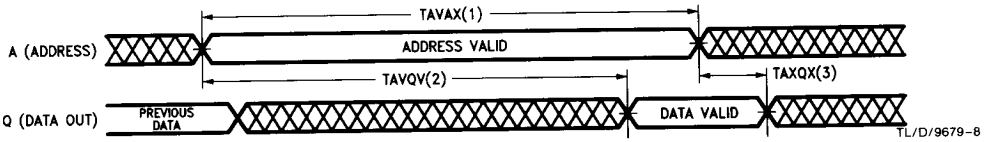
*The device will withstand undershoots to $-3.0V$ of 20 ns duration.

AC Electrical Characteristics $T_A = 0°C$ to $+70°C$, $V_{CC} = V_{CC\ MIN}$ to $V_{CC\ MAX}$

No.	Symbol		Parameter	NM1624-25/255 NM1625-25/255		NM1624-30 NM1625-30		NM1624-35 NM1625-35		Units
	Standard	Alternate		Min	Max	Min	Max	Min	Max	
READ CYCLES										
1	TAVAX	TRC	Address Valid to Address Invalid (Read Cycle Time)	25		30		35		ns
2	TAVQV	TAA	Address Valid to Output Valid (Address Access Time) (Note 5)		25		30		35	ns
3	TAXQX	TOH	Address Invalid to Output Invalid (Output Hold Time)	5		5		5		ns
4	TELEH	TRC	Chip Enable LOW to Chip Enable HIGH (Note 6)	22		27		30		ns
5	TELQV	TACS	Chip Enable LOW to Output Valid (Chip Enable Access Time) (Note 6)		22		27		30	ns
6	TELQX	TLZ	(Chip Enable LOW to Output Low Z (Chip Enable to Output Active) (Note 4)	5		5		5		ns
7	TEHQZ	THZ	Chip Enable HIGH to Output High Z (Chip Disable to Output Disable) (Note 9)	0	10	0	12	0	15	ns
8	TELICC	TPU	Chip Enable LOW to Operating Supply Current (Note 4)	0		0		0		ns
9	TEHISB	TPD	Chip Enable HIGH to Standby Current (Note 4)		25		27		30	ns
10	TGLQV	TOE	Output Enable LOW to Output Valid (Output Enable Access)		10		12		15	ns
11	TGLQX	TOLZ	Output Enable LOW to Output Invalid (Output Enable to Output Active) (Note 4)	0		0		0		ns
12	TGHQZ	TOHZ	Output Enable HIGH to Output High Z (Output Enable Off to Output High Z) (Note 9)		10		12		15	ns
13	TGHQX		Output Enable HIGH to Output Invalid (Output Hold Time) (Note 4)	0		0		0		ns

Timing Waveforms

Read Cycle 1



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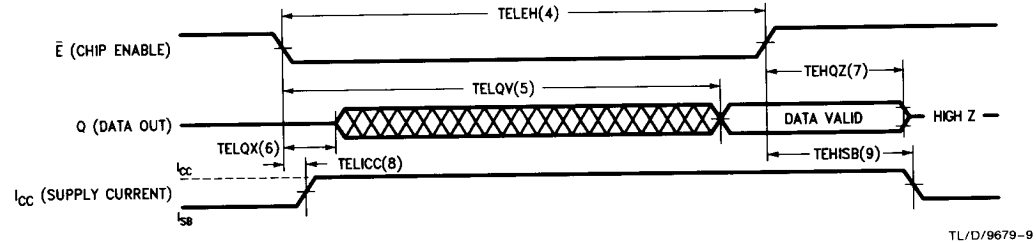
Access is under address control where $\overline{E}$ is active prior to 5 ns of address change. $\overline{W}$ = HIGH, $\overline{G}$ = LOW.

Read Cycle 2



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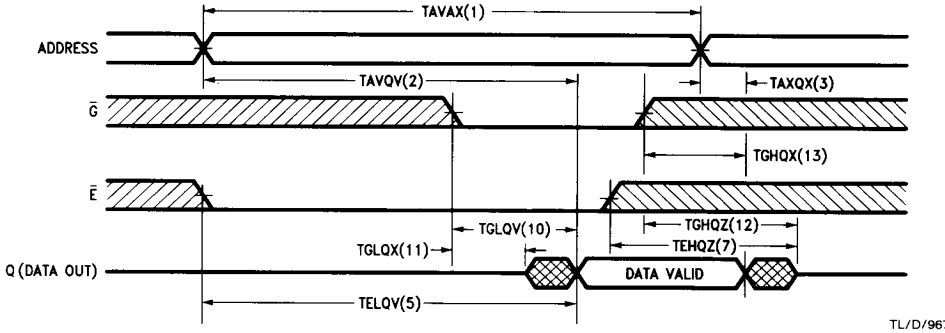
Access is under $\overline{E}$ control where address is valid a minimum of 5 ns prior to $\overline{E}$ becoming active (LOW). $\overline{W}$ = HIGH, $\overline{G}$ = LOW. Address remains valid at least TELQV after $\overline{E}$ transitions LOW.

Timing Waveforms (Continued)

Read Cycle 3



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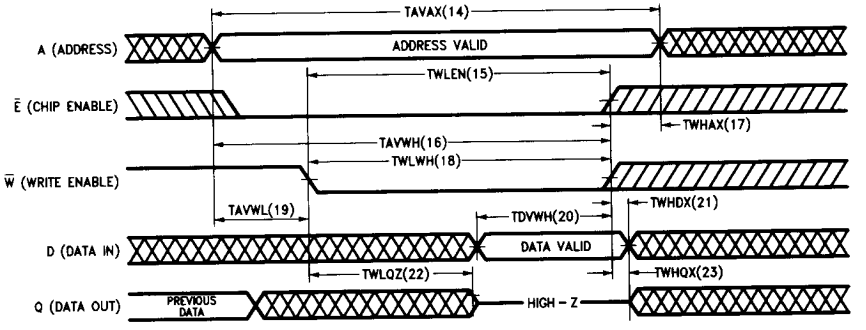
Access is under $\overline{G}$ control. $\overline{W}$ = HIGH.

AC Electrical Characteristics $T_A = 0°C$ to $+70°C$, $V_{CC} = V_{CC\ MIN}$ to $V_{CC\ MAX}$ (Continued)

No.	Symbol		Parameter	NM1624-25/255 NM1625-25/255		NM1624-30 NM1625-30		NM1624-35 NM1625-35		Units
	Standard	Alternate		Min	Max	Min	Max	Min	Max	
WRITE CYCLE 1										
14	TAVAX	TWC	Address Valid to Address Invalid (Write Cycle Time)	25		30		35		ns
15	TWLEH	TWP	Write LOW to Chip Enable HIGH (Write Pulse Width) (Notes 7 & 10)	19		22		25		ns
16	TAVWH	TAW	Address Valid to Write HIGH (Address Setup to End of Write) (Note 7)	19		22		25		ns
17	TWHAX	TAH	Write HIGH to Address Don't Care (Address Hold after End of Write) (Notes 7 & 12)	0		0		0		ns
18	TWLWH	TWP	Write LOW to Write HIGH (Write Pulse Width) (Notes 7 & 10)	19		22		25		ns
19	TAVWL	TAS	Address Valid to Write LOW (Address Setup to Beginning of Write) (Notes 7 & 8)	0		0		0		ns
20	TDVWH	TDS	Data Valid to Write HIGH (Data Setup to End of Write) (Notes 7 & 12)	10		10		12		ns
21	TWHDX	TDH	Write HIGH to Data Don't Care (Data Hold after End of Write) (Notes 7 & 12)	0		0		0		ns
22	TWLQZ	TWZ	Write LOW to Output High Z (Write Enable to Output Disable) (Note 9)	0	9	0	12	0	12	ns
23	TWHQX	TOW	Write HIGH to Output Don't Care (Output Active after End of Write) (Note 4)	5		5		5		ns

Timing Waveforms (Continued)

Write Cycle 1



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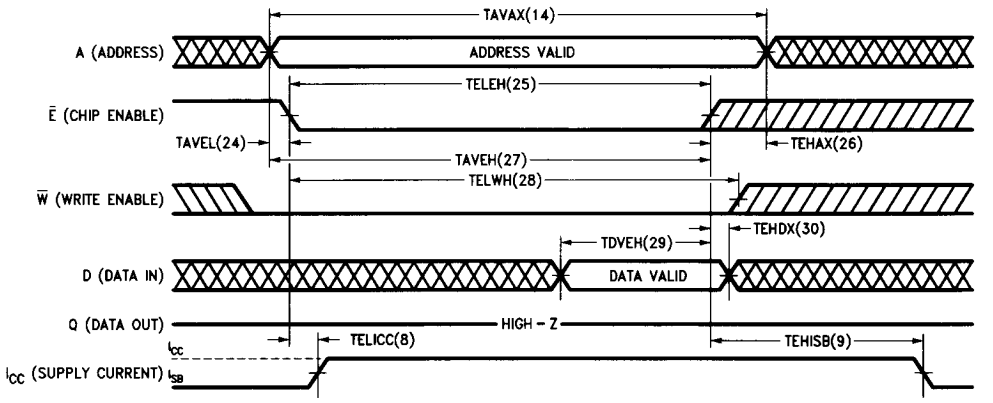
$\overline{W}$ controlled where $\overline{E}$ is active (LOW) prior to $\overline{W}$ becoming active (LOW). $\overline{G}$ = HIGH. In this write cycle the data bus DQ may become active (Q), requiring observance of TWLQZ to avoid data bus contention. At the end of the write cycle the data bus may become active (Q) if $\overline{W}$ becomes inactive (HIGH) prior to $\overline{E}$ becoming inactive (HIGH).

AC Electrical Characteristics $T_A = 0°C$ to $+70°C$, $V_{CC} = V_{CC\ MIN}$ to $V_{CC\ MAX}$ (Continued)

No.	Symbol		Parameter	NM1624-25/255 NM1625-25/255		NM1624-30 NM1625-30		NM1624-35 NM1625-35		Units
	Standard	Alternate		Min	Max	Min	Max	Min	Max	
WRITE CYCLE 2										
24	TAVEL	TAS	Address Valid to Chip Enable LOW (Address Setup) (Notes 7 & 8)	0		0		0		ns
25	TELEH	TWP	Chip Enable LOW to Chip Enable HIGH (Write Pulse Width) (Notes 7 & 10)	19		22		25		ns
26	TEHAX	TAH	Chip Enable HIGH to Address Don't Care (Address Hold after End of Write) (Notes 7 & 12)	0		0		0		ns
27	TAVEH	TAW	Address Valid to Chip Enable HIGH (Address Setup to End of Write) (Note 7)	19		22		25		ns
28	TELWH	TWP	Chip Enable LOW to Write HIGH (Write Pulse Width) (Notes 7 & 10)	19		22		25		ns
29	TDVEH	TDS	Data Valid to Chip Enable HIGH (Data Setup to End of Write) (Notes 7 & 12)	10		10		12		ns
30	TEHDX	TDH	Chip Enable HIGH to Data Don't Care (Data Hold) (Notes 7 & 12)	0		0		0		ns

Timing Waveforms (Continued)

Write Cycle 2



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This write cycle is $\overline{E}$ controlled, where $\overline{W}$ is active (LOW) prior to, or coincident with, $\overline{E}$ becoming active (LOW). $\overline{G} = V_{IH}$. In this write cycle the data out remains in the high impedance state (TRI-STATE) at the beginning of the write cycle, precluding potential data bus contention.

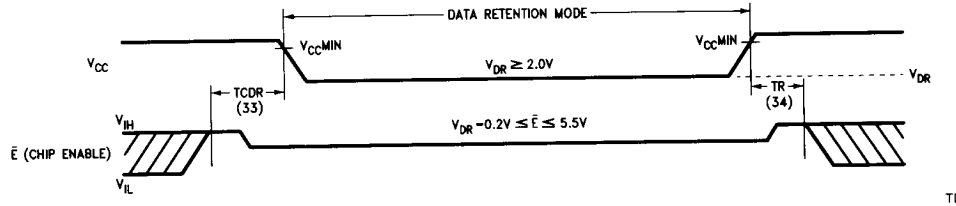
DC Electrical Characteristics $T_A = 0°C$ to $+70°C$, $V_{SS} = 0V$

Symbol	Parameter		Conditions	NM1624-25/255 NM1625-25/255		NM1624-30 NM1625-30		NM1624-35 NM1625-35		Units
				Min	Max	Min	Max	Min	Max	
I_{LI}	Input Leakage Current (Except DQ)		$V_{SS} \le V_{IN} \le V_{CC}$		±2		±2		±2	µA
I_{LO}	Output Leakage Current (DQ)		$\overline{E} = V_{IH}$ or $\overline{W} = V_{IL}$ $V_{SS} \le V_{OUT} \le V_{CC}$		±10		±10		±10	µA
I_{CC}	Dynamic Operating Supply Current		Min Read Cycle Time Duty Cycle = 100% Output Open		120		100		90	mA
I_{SB1}	Standby Supply Current		$\overline{E} = V_{IH}$ (Note 1)		25		25		25	mA
I_{SB2}	Full Standby Supply Current	NM1624	(Note 2)		15		15		15	mA
		NM1625			5		5		5	
V_{OL}	Output LOW Voltage		$I_{OL} = 8.0$ mA All Outputs under Load		0.4		0.4		0.4	V
V_{OH1}	Output HIGH Voltage		$I_{OH1} = -4.0$ mA All Outputs under Load	2.4		2.4		2.4		V
V_{OH2}	Output HIGH Voltage		$I_{OH2} = -0.05$ mA Other Outputs Open	$V_{CC}-0.4$		$V_{CC}-0.4$		$V_{CC}-0.4$		V
V_{CC}	Operating Supply		Except Data Retention Mode	**-25**		4.5	5.5	4.5	5.5	V
				4.5	5.5					
				-255						
				4.75	5.5					

Data Retention Characteristics $T_A = 0°C$ to $+70°C$, $V_{CC} = 2.0V$ to $5.5V$ (NM1625 only)

No.	Symbol	Parameter	Conditions		Min	Max	Units
31	V_{DR}	V_{CC} Voltage for Data Retention (Note 15)	$V_{CC} - 0.2V \le \overline{E} \le +5.5V$ $V_{CC} - 0.2V \le V_{IN} \le +5.5V$ or $V_{SS} - 0.2V \le V_{IN} \le V_{SS} + 0.2V$		2.0	5.5	V
32	I_{CCDR}	Data Retention Current (Note 14)	$V_{DR} = 2.0V$	$T_A = 0°C$ to $70°C$		35	µA
			$V_{DR} = 3.0V$	$T_A = 0°C$ to $70°C$		50	
33	TCDR	Chip Disable to Data Retention Time (Note 4)			0		ns
34	TR	Recovery Time (Notes 4 & 13)			TAVAX		ns

Data Retention Waveform



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Note 1: Standby supply current (TTL) is measured with $\overline{E}$ HIGH (chip deselected) and inputs steady state at valid V_{IL} or V_{IH} levels.

Note 2: Full standby supply current (CMOS) is measured with the enable bar input satisfying the condition: $V_{CC} - 0.2V \leq \overline{E} \leq V_{CC} + 0.2V$, and all other inputs, (including the data inputs) at steady state and satisfying one of two conditions. Either $V_{CC} - 0.2V \leq V_{IN} \leq V_{CC} + 0.2V$ or $V_{SS} - 0.2V \leq V_{IN} \leq V_{SS} + 0.2V$. This condition results in a significant reduction in current in the input buffers and consequently a lower overall current level.

Note 3: Operation to specifications guaranteed 2.0 ms after V_{CC} reaches minimum operating voltage.

Note 4: This parameter is sampled, not 100% tested.

Note 5: Address Access Time (Read Cycle 1) assumes that $\overline{E}$ occurs before, or within 5 ns after addresses are valid. Timing considerations are referenced to the edges of Address Valid.

Note 6: Enable Access Time (Read Cycle 2) assumes that addresses are valid at least 5 ns prior to $\overline{E}$ transitioning LOW (active). Timing considerations are then referenced to the LOW (active) transitioning edge of $\overline{E}$.

Note 7: A write condition exists only during intervals where both $\overline{W}$ and $\overline{E}$ are LOW (active). The internal Write starts when the second of these signals becomes LOW (active). The internal Write ends when either of these signals transitions HIGH (inactive).

Note 8: Address setup to beginning of write is measured from the time when the last address input becomes valid to the time when the second of the two signals ($\overline{E}$ or $\overline{W}$) becomes LOW (active). The timing of the first signal ($\overline{W}$ or $\overline{E}$) to transition LOW (active) is a Don't Care.

Note 9: Transition to the high-impedance state is measured at a ± 500 mV change from a valid V_{OH} of V_{OL} steady state voltage with the loading specified in *Figure 2*. This parameter is sampled, not 100% tested.

Note 10: Write pulse width is measured from the time when the last of the two signals $\overline{E}$ and $\overline{W}$ becomes LOW (active) to the time of the first of $\overline{E}$ or $\overline{W}$ to transition HIGH (inactive).

Note 11: For rise or fall times greater than 3 ns, the timing relationships can no longer be specified to the time when inputs cross the 1.5V level. This is a characteristic of any CMOS device operated outside specified switching levels or transition times.

Note 12: Timing specifications of Data Setup to End of Write, Data Hold after End of Write, and Address Hold after End of Write are all referenced to the time when the first of $\overline{E}$ or $\overline{W}$ transitions HIGH (inactive). The timing of the second signal ($\overline{W}$ or $\overline{E}$) to transition HIGH (inactive) is a Don't Care.

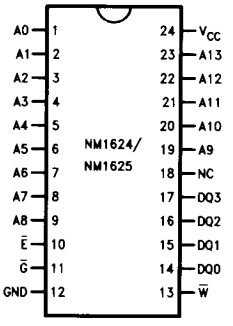
Note 13: TAVAX = Read Cycle Timing.

Note 14: I_{CCDR} is tested with $V_{IN} = 0V$ and $V_{IN} = V_{DR}$.

Note 15: V_{IN} applies to all inputs other than $\overline{E}$ and DQ_0–DQ_3. Input conditions for DQ_0–DQ_3 are: $V_{SS} - 0.2V \leq DQ \leq V_{SS} + 0.2V$ or $V_{CC} - 0.2V \leq DQ \leq V_{CC} + 0.2V$.

Connection Diagrams

24-Pin DIP (J) and PDIP (N)



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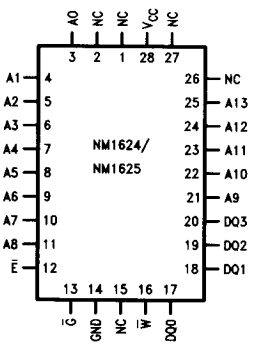
Top View

Order Number NM1624J25, NM1624J255, NM1624J30, NM1624J35, NM1624N25, NM1624N255, NM1624N30, NM1624N35, NM1625J25, NM1625J255, NM1625J30, NM1625J35, NM1625N25, NM1625N255, NM1625N30 or NM1625N35
See NS Package Number D24H* or N24D*

28-Pin LCC (E)



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Top View

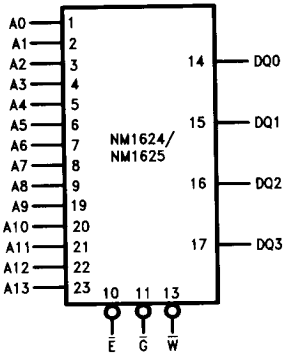
Order Number NM1624E25, NM1624E255, NM1624E30, NM1624E35, NM1625E25, NM1625E255, NM1625E30 or NM1625E35
See NS Package Number E28B

Pin Names

A_0–A_{13}	Address Inputs
$\overline{E}$	Chip Enable Bar
$\overline{W}$	Write Enable Bar
$\overline{G}$	Output Enable Bar
DQ_0–DQ_3	Data Inputs/Outputs
V_{CC}	Power (+5.0V)
V_{SS}	Ground (0V)
NC	No Connect

Logic Symbols

DIP, PDIP



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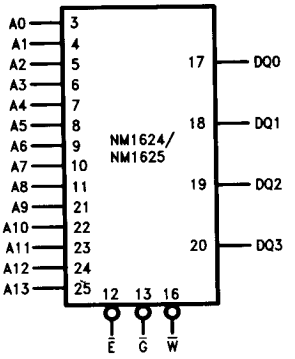
LCC



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AC Test Conditions (Notes 3 & 11)

Input Pulse Levels	0V to 3.0V
Input Rise and Fall Times	3 ns
Input and Output Timing Reference Levels	1.5V
Output Load	See *Figures 1* and *2*

Capacitance (Note 4)

Symbol	Parameter	Max	Units
C_{IN}	Input Capacitance	6	pF
C_{OUT}	Output Capacitance	7	pF

Effective capacitance calculated from the equation

$C = \frac{\Delta Q}{\Delta V}$ where $\Delta V = 3V$

Truth Table

Mode	$\overline{E}$	$\overline{W}$	$\overline{G}$	DQ_X	Power Level
Standby	H	X	X	High Z	Standby
Read	L	H	L	Q_{OUT}	Active
Read	L	H	H	High Z	Active
Write	L	L	X	D_{IN}	Active

High Z = High impedance
D = Valid data bit in
X = Don't care
Q = Valid data bit out

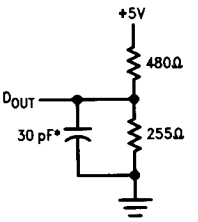

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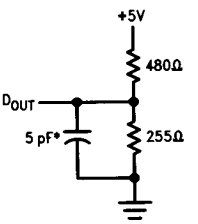
FIGURE 1. Output Load



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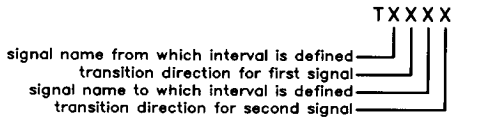
*including scope and jig

FIGURE 2. Output Load (for TEHQZ, TELQX, TWLQZ, TWHQX, TGHQX, TGLQX, TGHQZ)

STANDARD TIMING PARAMETER ABBREVIATIONS



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The transition definitions used in this data sheet are:

H = transition to high state.

L = transition to low state.

V = transition to valid state.

X = transition to invalid or don't care condition.

Z = transition to off (high impedance) condition.

TIMING VALUES

The AC Operating Conditions and Characteristics tables typically show either a minimum or maximum limit for each device parameter. Those timing parameters which state a minimum value do so because the system must supply at least that much time, even though most devices don't require that full amount. Thus, input requirements are specified from the external point of view. In contrast, responses from the memory (like access times) are specified as a maximum time because the device will never provide the data later than this stated value, and will usually provide it much sooner than this.

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INVALID or Don't Care

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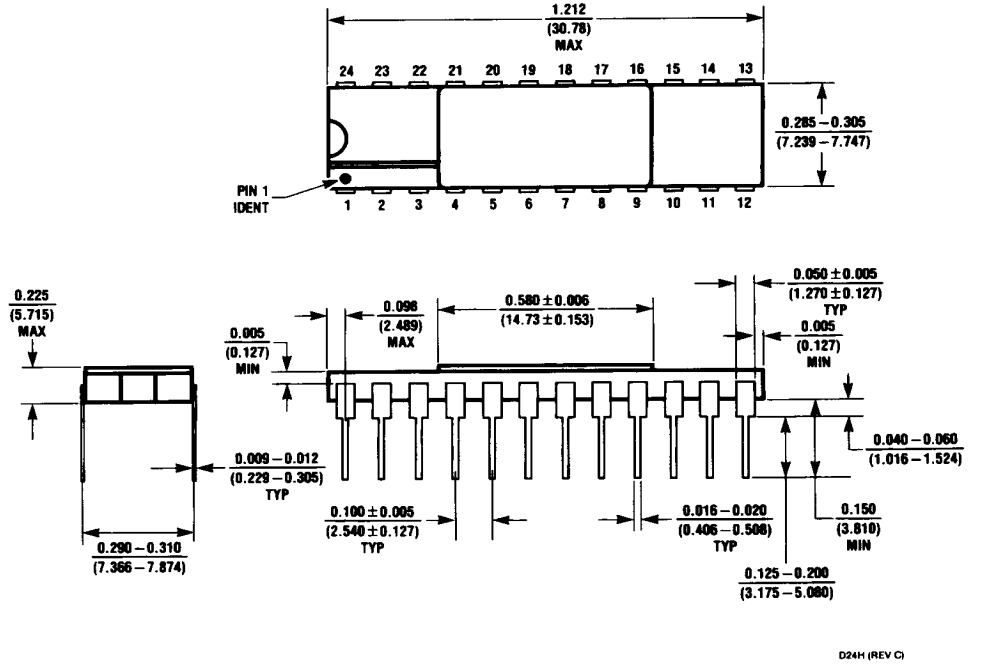
Transition from HIGH to LOW level may occur any time during this period

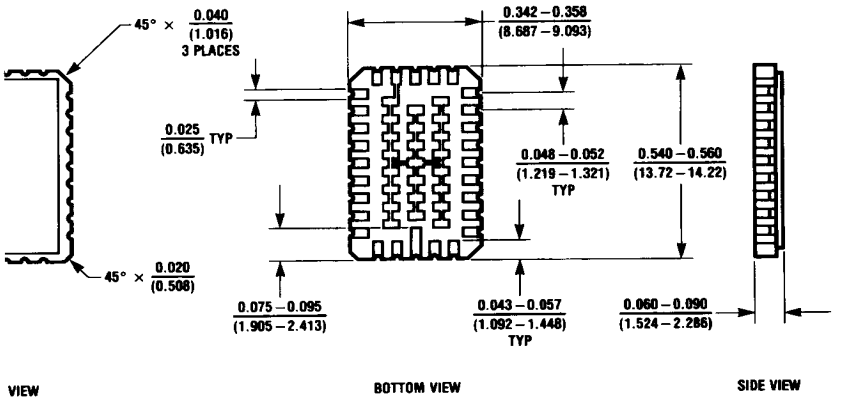
TL/D/9679–17

Transition from LOW to HIGH level may occur any time during this period

Physical Dimensions inches (millimeters)

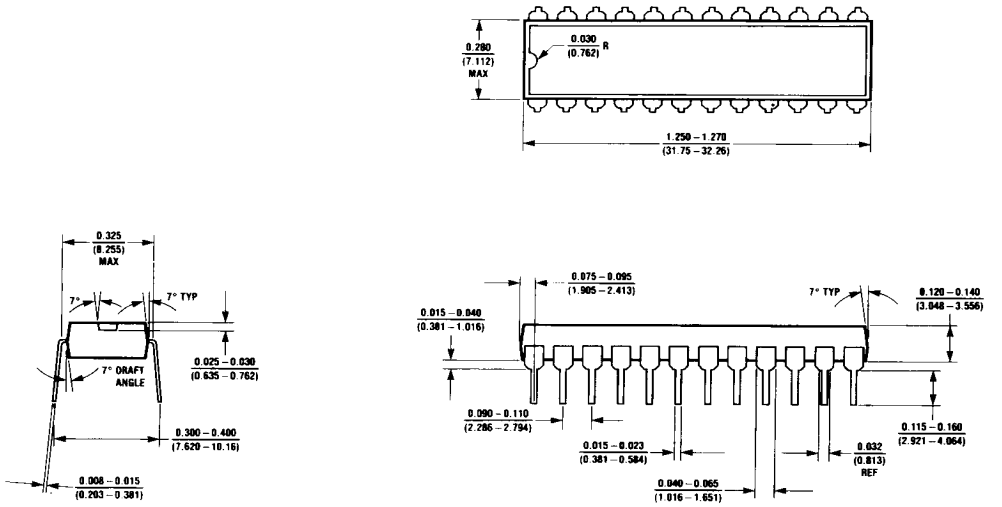


24-Pin Side-Brazed Package (J)
Order Number NM1624J25, NM1624J255, NM1624J30, NM1624J35, NM1625J25, NM1625J255, NM1625J30 or NM1625J35
NS Package Number D24H



28-Pin Leadless Chip Carrier (E)
Order Number NM1624E25, NM1624E255, NM1624E30, NM1624E35, NM1625E25, NM1625E255, NM1625N30 or NM1625E35
NS Package Number E28B

Physical Dimensions inches (millimeters) (Continued)



N24D (REV 0)

24-Pin Plastic DIP Package* (N)
Order Number NM1624N25, NM1624N255, NM1624N30, NM1624N35, NM1625N25, NM1625N255, NM1625N30 or NM1625N35
NS Package Number N24D

*Call factory for package outlines & dimensions.

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LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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