

**MOS
LSI**

**TMS 40L45 JL, NL; TMS 40L47 JL, NL
1024-WORD BY 4-BIT STATIC RAM;**

NOVEMBER 1977

- 1024 x 4 Organization
- Single 10% Tolerance 5-V Supply
- High Density 300-mil 18- and 20-Pin Packages
- Fully Static Operation (No Clocks, No Refresh, No Timing Strobe)
- 3 Performance Ranges:

| | ACCESS TIME (MAX) | READ OR WRITE CYCLE (MIN) |
|----------------------------|-------------------------|---------------------------------|
| TMS 40L45-25, TMS 40L47-25 | 250 ns | 250 ns |
| TMS 40L45-30, TMS 40L47-30 | 300 ns | 300 ns |
| TMS 40L45-45, TMS 40L47-45 | 450 ns | 450 ns |

- 400-mV Guaranteed Noise Immunity With Standard TTL Loads – No Pull-Up Resistors Required
- Common I/O With Three-State Outputs and Chip Select Control for OR-Tie Capability
- Fan-Out to 1 Series 74 or 74S TTL Load – No Pull-Up Resistors Required
- Low Power Dissipation
250 mW *Typical
370 mW *Maximum
- Standby Power Dissipation (TMS 40L47)
12 mW Typical
24 mW Maximum

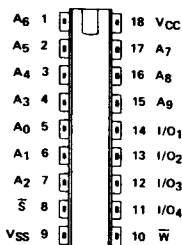
description

This series of low power static random-access memories is organized as 1024 words of 4 bits. Static design results in reduced overhead costs by elimination of refresh-clocking circuitry and by simplification of timing requirements. Because this series is fully static, chip select may be tied low to further simplify system timing. Output data is always available during a read cycle.

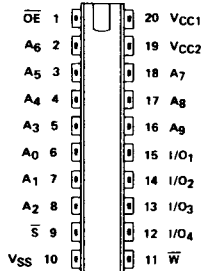
All inputs and outputs are fully compatible with Series 74 or 74S TTL. No pull-up resistors are required. The TMS 40L45/40L47 series is manufactured using TI's reliable N-channel silicon-gate technology to optimize the cost/performance relationship. Both the TMS 40L45 and 40L47 are characterized to retain data at $V_{CC} = 2.4$ V to reduce power dissipation. Furthermore for applications such as battery backup, the TMS 40L47 has separate V_{CC} pins for the array and periphery, and data will be retained if power solely to the array is maintained.

*5% supply tolerance

TMS 40L45
18-PIN CERAMIC AND PLASTIC
DUAL-IN-LINE PACKAGES
(TOP VIEW)



TMS 40L47
20-PIN CERAMIC AND PLASTIC
DUAL-IN-LINE PACKAGES
(TOP VIEW)



| PIN NAMES | |
|------------------------------------|---------------------------------|
| A ₀ -A ₉ | Addresses |
| I/O ₁ -I/O ₄ | Data input/output |
| OE | Output Enable |
| S | Chip Select |
| V _{CC} (TMS 40L45) | +5-V Supply |
| V _{CC1} (TMS 40L47) | +5-V Supply (array only) |
| V _{CC2} (TMS 40L47) | +5-V Supply (periphery only) |
| V _{SS} | Ground |
| W | Write Enable |

TMS 40L45 JL, NL; TMS 40L47 JL, NL 1024-WORD BY 4-BIT STATIC RAMs

SRAMs

The TMS 40L45 series and the TMS 40L47 series are offered in 18-pin and 20-pin respectively dual-in-line ceramic (JL suffix) and plastic (NL suffix) packages designed for insertion in mounting-hole rows on 300-mil centers. The series is designed for operation from 0°C to 70°C.

Operation

Addresses (A0-A9)

The ten address inputs select one of the 1024 4-bit words stored in the RAM. The address-inputs must be stable for the duration of a write cycle. The address inputs can be driven directly from standard Series 54/74 TTL with no external pull-up resistors.

Output enable (\overline{OE})

The output enable terminal, which can be driven directly from standard TTL circuits, affects only the data-in/data-out terminals. When output enable is at a logic high level, the I/O terminals are disabled to the high-impedance state. Output enable provides greater output control flexibility, simplifying data bus design.

Chip select (\overline{CS})

The chip-select terminal, which can be driven directly from standard TTL circuits, affects the data-in/data-out terminals. When chip select and output enable are at a logic low level, the I/O terminals are enabled. When chip select is high, the I/O terminals are in the floating or high-impedance state and the input is inhibited.

Write enable (\overline{WE})

The read or write mode is selected through the write enable terminal. A logic high selects the read mode; a logic low selects the write mode. \overline{WE} must be high when changing addresses to prevent erroneously writing data into a memory location. The \overline{WE} input can be driven directly from standard TTL circuits.

Data-in/data-out (I/O₁-I/O₄)

Data can be written into a selected device when the write enable input is low. The I/O terminal can be driven directly from standard TTL circuits. The three-state output buffer provides direct TTL compatibility with a fan-out of one Series 74 TTL gate or one Series 74S TTL gate. The I/O terminals are in the high impedance state when chip select (\overline{CS}) is high or whenever a write operation is being performed. Data-out is the same polarity as data-in.

Standby operation

There are two basic standby modes available to retain data when operating the TMS 40L45/40L47 series:

1. Reduce the V_{CC} supply to 2.4 V
2. Supply power to the array only (TMS 40L47 only).

Combining 1 and 2 on the TMS 40L47 will produce the lowest possible standby power while retaining data.

| DEVICE | SUPPLY | OPERATING | STANDBY | |
|-----------|-----------|-----------|---------|--------|
| TMS 40L45 | V_{CC} | +5 V | +2.4 V | |
| | V_{CC1} | +5 V | +5 V | +2.4 V |
| TMS 40L47 | V_{CC2} | +5 V | 0 V | 0 V |

(Nominal supply values)

During standby operation, data cannot be read or written into the memory. When resuming normal operation, five cycle times must be allowed after normal supplies are returned for the memory to resume steady-state operating conditions.

TMS 40L45 JL, NL; TMS 40L47 JL, NL 1024-WORD BY 4-BIT STATIC RAMs

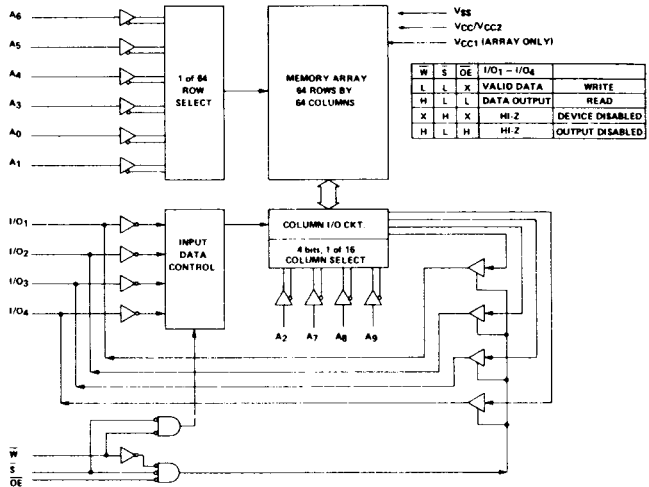
absolute maximum ratings over operating free-air temperature range (unless otherwise noted)*

| | |
|--|----------------|
| Supply voltage, V_{CC} (see Note 1) | -0.5 to 7 V |
| Input voltage (any input) (see Note 1) | -0.5 to 7 V |
| Continuous power dissipation | 1 W |
| Operating free-air temperature range | 0°C to 70°C |
| Storage temperature range | -55°C to 150°C |

NOTE 1: Voltage values are with respect to the ground terminal.

*Stresses beyond 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 beyond those indicated in the "Recommended Operating Conditions" section of this specification is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

functional block diagram



recommended operating conditions

| PARAMETER | | MIN | NOM | MAX | UNIT |
|--|-----------|------|-----|-----|------|
| Supply voltage, V_{CC} (TMS 40L45) | Operating | 4.5 | 5 | 5.5 | V |
| | Standby | 2.4 | 5 | 5.5 | |
| Supply voltage (array only), V_{CC1} (TMS 40L47) | Operating | 4.5 | 5 | 5.5 | V |
| | Standby | 2.4 | 5 | 5.5 | |
| Supply voltage (periphery only), V_{CC2} (TMS 40L47) | Operating | 4.5 | 5 | 5.5 | V |
| | Standby | 0 | 0 | 5.5 | |
| Supply voltage, V_{SS} | | | 0 | | V |
| High-level input voltage, V_{IH} | | 2 | | 5.5 | V |
| Low-level input voltage, V_{IL} | | -0.3 | | 0.8 | V |
| Operating free-air temperature, T_A | | 0 | | 70 | °C |

TMS 40L45 JL, NL; TMS 40L47 JL, NL

24-WORD BY 4-BIT STATIC RAMs

Electrical characteristics over recommended operating free air temperature range
(unless otherwise noted)

| PARAMETER | TEST CONDITIONS | | MIN | TYP [†] | MAX | UNIT |
|---|---|-------------------------------------|---------------------------|------------------|-----|---------------|
| | High level voltage | $I_{OH} = -200 \mu\text{A}$ | $V_{CC} = 4.75 \text{ V}$ | 2.4 | | |
| | | $V_{CC} = 4.5 \text{ V}$ | 2.2 | | | |
| Low level voltage | $I_{OL} = 2 \text{ mA}$ | $V_{CC} = 4.5 \text{ V}$ | | | 0.4 | V |
| Input current | $V_I = 0 \text{ V to } 5.5 \text{ V}$ | | | | 10 | μA |
| Off-state output current | S or OE at 2 V or W at 0.8 V | $V_O = 0 \text{ to } 5.5 \text{ V}$ | | | 10 | μA |
| Supply current from V_{CC} | $I_O = 0 \text{ mA}$, $T_A = 0^\circ\text{C}$ (worst case) | $V_{CC} = 5.5 \text{ V}$ | 55 | 70 | | mA |
| | | $V_{CC} = 2.4 \text{ V}$ | 40 | 50 | | |
| Supply current from V_{CC1} (array only) | $I_O = 0 \text{ mA}$, $T_A = 70^\circ\text{C}$ (worst case) | $V_{CC} = 5.5 \text{ V}$ | 5 | 20 | | mA |
| | | $V_{CC} = 2.4 \text{ V}$ | 5 | 10 | | |
| Supply current from V_{CC2} (periphery only) | $I_O = 0 \text{ mA}$, $T_A = 0^\circ\text{C}$ (worst case) | $V_{CC} = 5.5 \text{ V}$ | 50 | 70 | | mA |
| | | | | | | |
| Input capacitance | $V_I = 0 \text{ V}$, | $f = 1 \text{ MHz}$ | | | 8 | pF |
| Output capacitance | $V_O = 0 \text{ V}$, | $f = 1 \text{ MHz}$ | | | 12 | pF |

[†]Typical values are at $V_{CC} = 5 \text{ V}$, $T_A = 25^\circ\text{C}$.

Timing requirements over recommended supply voltage range and operating free-air temperature range

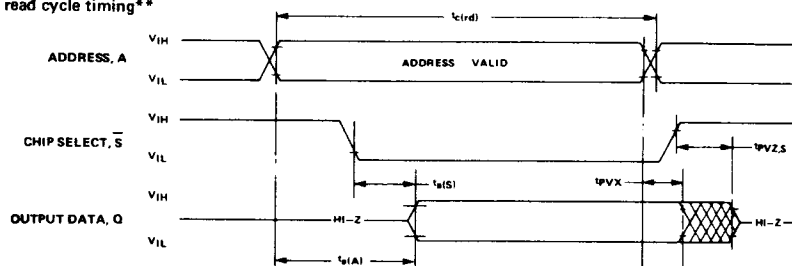
| PARAMETER | TMS 40L45-25 | | TMS 40L45-30 | | TMS 40L45-45 | | UNIT |
|---|--------------|-----|--------------|-----|--------------|-----|------|
| | TMS 40L47-25 | | TMS 40L47-30 | | TMS 40L47-45 | | |
| | MIN | MAX | MIN | MAX | MIN | MAX | |
| t _{rd} Read cycle time | 250 | | 300 | | 450 | | ns |
| t _{we} Write cycle time | 250 | | 300 | | 450 | | ns |
| t _{wi} Write pulse width | 100 | | 150 | | 200 | | ns |
| t _{AS} Address set up time | 0 | | 0 | | 0 | | ns |
| t _{CS} Chip select set up time | 100 | | 150 | | 200 | | ns |
| t _{DS} Data set up time | 100 | | 150 | | 200 | | ns |
| t _{DH} Data hold time | 0 | | 0 | | 0 | | ns |
| t _{AH} Address hold time | 20 | | 20 | | 20 | | ns |
| t _{AA} Address transition time | 5 | 200 | 5 | 200 | 5 | 200 | ns |

TMS 40L45 JL, NL; TMS 40L47 JL, NL 1024-WORD BY 4-BIT STATIC RAMs

switching characteristics over recommended voltage range, $T_A = 0^\circ\text{C}$ to 70°C ,
1 series 74 TTL load, $C_L = 100\text{ pF}$

| PARAMETER | TMS 40L45-25 TMS 40L47-25 | | | TMS 40L45-30 TMS 40L47-30 | | | TMS 40L45-45 TMS 40L47-45 | | | UNIT |
|---|------------------------------|-----|-----|------------------------------|-----|-----|------------------------------|-----|-----|------|
| | MIN | NOM | MAX | MIN | NOM | MAX | MIN | NOM | MAX | |
| $t_a(A)$ Access time from address | | | 200 | | | 300 | | | 450 | ns |
| $t_a(S)$ Access time from chip select (or output enable) low | | | 100 | | | 100 | | | 120 | ns |
| $t_a(W)$ Access time from write enable high | | | 100 | | | 100 | | | 120 | ns |
| t_{PVX} Output data valid after address change | 10 | | | 10 | | | 10 | | | ns |
| $t_{PVZ,S}$ Output disable time after chip select (or output enable) high | | 40 | | | 80 | | | 100 | | ns |
| $t_{PVZ,W}$ Output disable time after write enable high | | 40 | | | 80 | | | 100 | | ns |

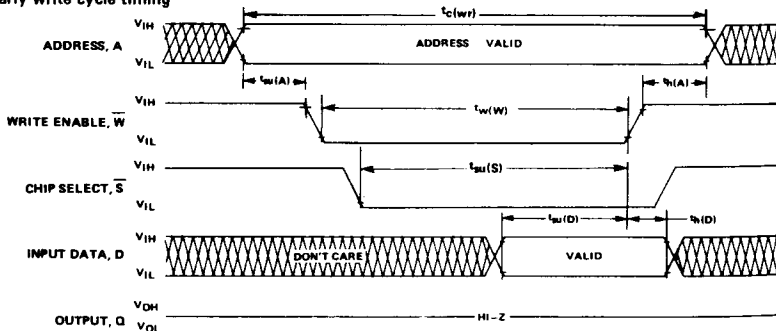
read cycle timing**



All timing reference points are 0.8 V and 2.0V on inputs and 0.6 V and 2.2 V on outputs (90% points). Input rise and fall times equal 10 nanoseconds.

**Write enable is high for a read cycle.

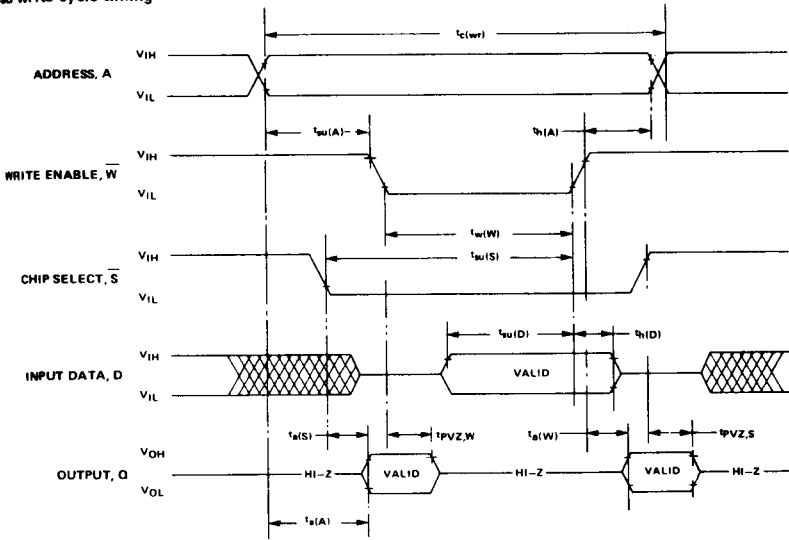
early write cycle timing



TMS 40L45 JL, NL; TMS 40L47 JL, NL
1024-WORD BY 4-BIT STATIC RAMs

SRAMs

write cycle timing



applications data

Early write cycle avoids I/O conflicts by controlling the write time with \bar{S} . In the diagram above, the write operation will be controlled by the leading edge of \bar{S} , not \bar{W} . Data can only be written when both \bar{S} and \bar{W} are low. Either \bar{S} or \bar{W} being high inhibits the write operation and data stored will not be affected by the address. To prevent erroneous data being written into the array, the addresses must be stable during the write cycle as defined by $t_{su}(A)$, $t_w(W)$, and $t_h(A)$.

PRINTED IN U.S.A.
 TI does not assume any responsibility for any circuits shown
 herein that may be subject to patent infringement.
 TEXAS INSTRUMENTS INCORPORATED
 POST OFFICE BOX 5012 • DALLAS, TEXAS 75222