# MOSTEK

## MILITARY/HIGH-REL PRODUCTS

## Processed to MIL-STD-883, Method 5004, Class B

# 2048 x 8-Bit UV Erasable PROM

# MKB2716(J/E)-86/87/88/90

### FEATURES

- Military temperature range ($-55°C \leq T_A \leq +125°C$)
- Qualified per Method 5005, MIL-STD 883. Group B, C, D data report available
- Available processed to DESC selected item drawing number 78022 (part no. 7802201JX)
- Pin compatible with Mostek's BYTEWYDE™ memory family
- Single +5 volt power supply during read operation
- Low power dissipation: 663 mW max active, 165 mW max standby
- Three state output OR-tie capability
- Five modes of operation for greater system flexibility (see Table)

| P/N | Access Time |
|---|---|
| MKB2716-86 | 350 ns |
| MKB2716-87 | 390 ns |
| MKB2716-88 | 450 ns |
| MKB2716-90 | 550 ns |

- Single programming requirement: single location programming with one 50 msec pulse
- Industrial MKI version available (-40°C to 85°C)
- TTL compatible in all operating modes
- Standard 24 pin JEDEC DIP pinout

### DESCRIPTION

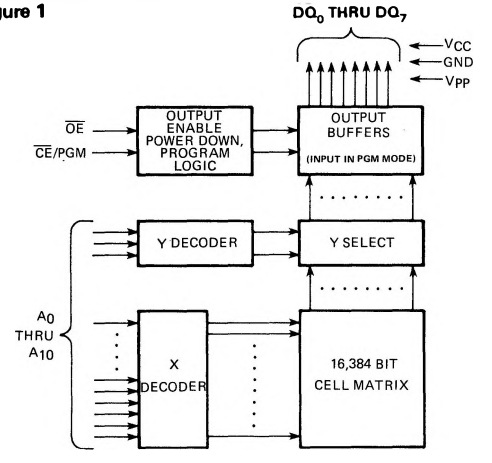
The MKB2716 is a 2048 x 8 bit electrically programmable/ ultraviolet erasable read only memory. The circuit is fabricated with Mostek's advanced N-channel silicon gate technology for the highest performance and reliability. The MKB2716 offers significant advances over hardwired logic cost, system flexibility, turnaround time and performance.

The device has many useful system oriented features including a standby mode of operation which lowers power from 633 mW maximum active power to 165 mW maximum for an overall savings of 75%.

Programming is done with a single TTL level pulse, and may

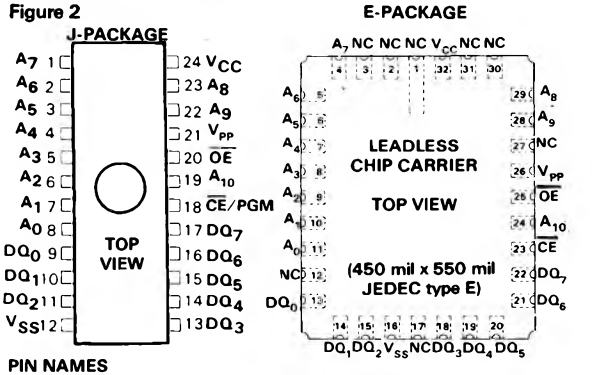
### BLOCK DIAGRAM

**Figure 1**




### PIN CONNECTIONS

**Figure 2**




### PIN NAMES

| | | | |
|---|---|---|---|
| $A_0$ - $A_{10}$ | Addresses | $DQ_0$ - $DQ_7$ | Data Outputs* |
| $\overline{CE}$/PGM | Chip Enable/ Program | $\overline{OE}$ | Output Enable |
| | | $V_{SS}$ | Ground |

*Inputs in Program Mode

## ABSOLUTE MAXIMUM RATINGS*

Voltage on any pin relative to $V_{SS}$ (Except $V_{PP}$) ..... -0.3 V to +6 V
Voltage on $V_{PP}$ supply pin relative to $V_{SS}$ ..... -0.3 V to +28 V
Operating Temperature $T_A$ (Ambient) ..... $-55°C \leq T_A \leq +125°C$
Storage Temperature (Ambient) ..... $-65°C \leq T_A \leq +125°C$
Power Dissipation ..... 1 Watt
Short Circuit Output Current ..... 50 mA

*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 operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## READ OPERATION

### RECOMMENDED DC OPERATING CONDITIONS

($-55°C \leq T_A \leq 125°C$)

| SYM | PARAMETER | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|
| $V_{IH}$ | Input High Voltage | 2.0 | | $V_{CC}+1$ | V | |
| $V_{IL}$ | Input Low voltage | -0.1 | | 0.8 | V | |

### DC ELETRICAL CHARACTERISTICS[1,2,4,8]

($-55°C \leq T_A \leq 125°C$) ($V_{CC}$ = +5 V ± 10%, $V_{PP} = V_{CC}$)[2]

| SYM | PARAMETER | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|
| $I_{CC1}$ | $V_{CC}$ Standby Power Supply Current (OE = $V_{IL}$; CE = $V_{IH}$) | | 10 | 30 | mA | 2 |
| $I_{CC2}$ | $V_{CC}$ Active Power Supply Current (OE = CE = $V_{IL}$) $T_A = -55°C$ | | 57 | 115 | mA | 2,10 |
| | $T_A = +125°C$ | | 43 | 90 | | |
| $I_{PP1}$ | $V_{PP}$ Current ($V_{PP}$ = 5.5 V) | | 2.0 | 10 | mA | 2 |
| $V_{OH}$ | Output High Voltage ($I_{OH}$ = -400 µA) | 2.4 | | | V | |
| $V_{OL}$ | Output Low Voltage ($I_{OL}$ = 2.1 mA) | | | .45 | V | |
| $I_{IL}$ | Input Leakage Current $V_{IN}$ = 5.5 V) | | | 10 | µA | |
| $I_{OL}$ | Output Leakage Current ($V_{OUT}$ = 5.5 V) | | | 10 | µA | |

### AC ELECTRICAL CHARACTERISTICS[1,2,5]

($-55°C \leq T_A \leq 125°C$) ($V_{CC}$ = +5 V ± 10%, $V_{PP} = V_{CC}$)[2]

| | | -86 | | -87 | | -88 | | -90 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SYM | PARAMETER | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | UNITS | NOTES |
| $t_{ACC}$ | Address to Output Delay ($\overline{CE}$ = $\overline{OE}$ = $V_{IL}$) | | 350 | | 390 | | 450 | | 550 | ns | |
| $t_{CE}$ | CE to Output Delay ($\overline{OE}$ = $V_{IL}$) | | 350 | | 390 | | 450 | | 550 | ns | 5 |
| $t_{OE}$ | Output Enable to Output Delay ($\overline{CE}$ = $V_{IL}$) | | 150 | | 150 | | 150 | | 180 | ns | 9 |
| $t_{DF}$ | Chip Deselect to Output Float ($\overline{CE}$ = $V_{IL}$) | 0 | 130 | 0 | 130 | 0 | 130 | 0 | 130 | ns | 8 |
| $t_{OH}$ | Address to Output Hold ($\overline{CE}$ = $\overline{OE}$ = $V_{IL}$) | 0 | | 0 | | 0 | | 0 | | ns | |

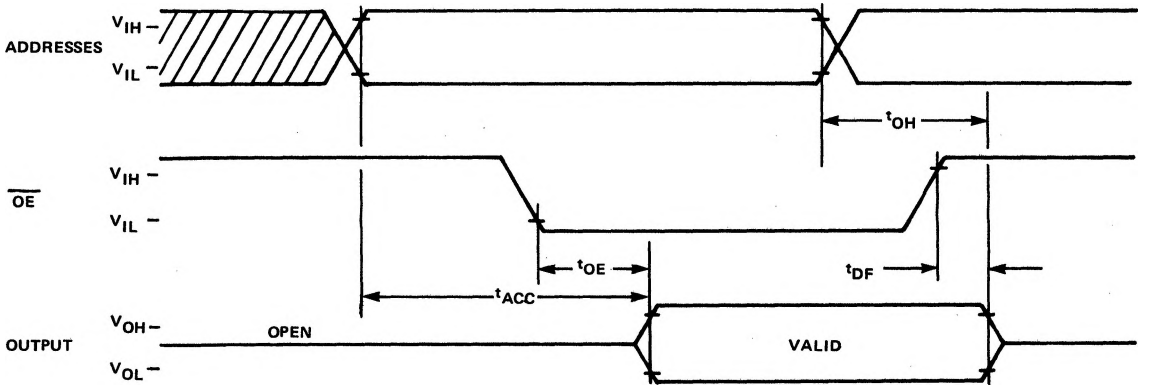
## CAPACITANCE
($T_A$ = 25°C)

| SYM | PARAMETER | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | 4 | 6 | pF | 6 |
| $C_{OUT}$ | Output Capacitance | 8 | 12 | pF | 6 |

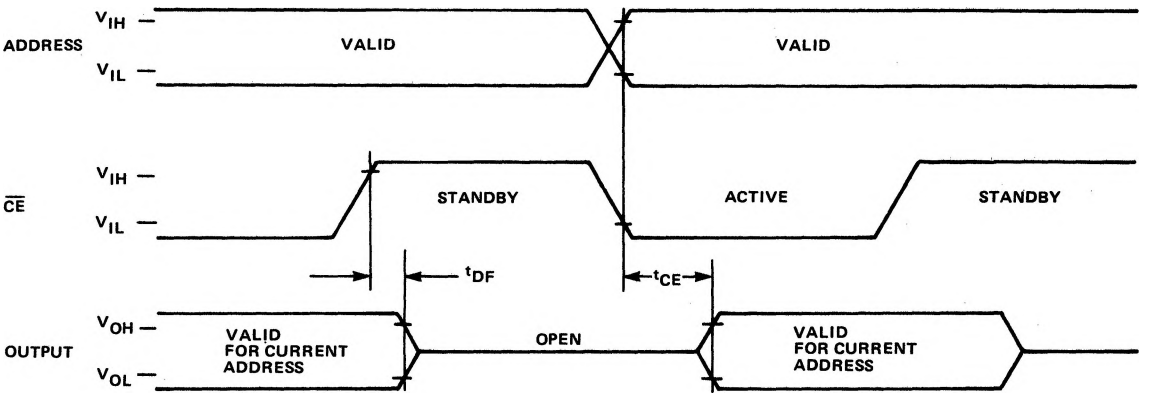
**READ OPERATION NOTES:**

1. $V_{CC}$ must be applied at the same time or before $V_{PP}$ and removed after or at the same time as $V_{PP}$.
2. $V_{PP}$ and $V_{CC}$ may be connected together except during programming. With $V_{PP}$ = $V_{CC}$, the supply current is the sum of $I_{CC}$ and $I_{PP1}$.
3. All voltages with respect to $V_{SS}$.
4. Load conditions = 1 TTL load and 100 pf, $t_r$ = $t_f$ = 20 ns, reference levels are 1 V and 2 V for inputs and .8 V and 2 V for outputs.
5. $t_{OE}$ is referenced to $\overline{CE}$ or the addresses, whichever occurs last.
6. Effective Capacitance calculated from the equation $C = \frac{\Delta Q}{\Delta V}$ where $\Delta V$ = 3V.
7. Typical numbers are for $T_A$ = 25°C and $V_{CC}$ = 5.0 V.
8. $t_{DF}$ is applicable to both $\overline{CE}$ and $\overline{OE}$, which occurs first.
9. $\overline{OE}$ may follow up to $t_{ACC}$-$t_{OE}$ after the falling edge of $\overline{CE}$ without affecting $t_{ACC}$.
10. Power consumption decreases with temperature from a maximum at low temperature to a minimum at high temperature.

## TIMING DIAGRAMS
## READ CYCLE ($\overline{CE}$ = $V_{IL}$)
**Figure 3**




## STANDBY POWER DOWN MODE ($\overline{OE}$ = $V_{IL}$)
**Figure 4**



## PROGRAM OPERATION

### RECOMMENDED DC OPERATING CONDITIONS[8]

($T_A$ = 25°C ± 5°C) ($V_{CC}$ = +5 V ± 10%, $V_{PP}$ = 25 V ± 1 V)

| SYM | PARAMETER | MIN | MAX | UNITS | NOTES |
|---|---|---|---|---|---|
| $V_{IL}$ | Input Low Level | -0.1 | 0.8 | V | |
| $V_{IH}$ | Input High Level | 2.0 | $V_{CC}$ + 1 | V | |

### DC ELECTRICAL CHARACTERISTICS

($T_A$ = 25°C ± 5°C) ($V_{CC}$ = +5 V ± 10%, $V_{PP}$ = 25 V ± 1 V)

| SYM | PARAMETER | MIN | MAX | UNITS | NOTES |
|---|---|---|---|---|---|
| $I_{IL}$ | Input Leakage Current | | 10 | μA | 3 |
| $I_{CC}$ | $V_{CC}$ Power Supply Current | | 100 | mA | |
| $I_{PP1}$ | $V_{PP}$ Supply Current | | 10 | mA | 4 |
| $I_{PP2}$ | $V_{PP}$ Supply Current during Programming Pulse | | 30 | mA | 5 |

### RECOMMENDED AC OPERATING CONDITIONS AND ELECTRICAL CHARACTERISTICS[1,2,6,7]

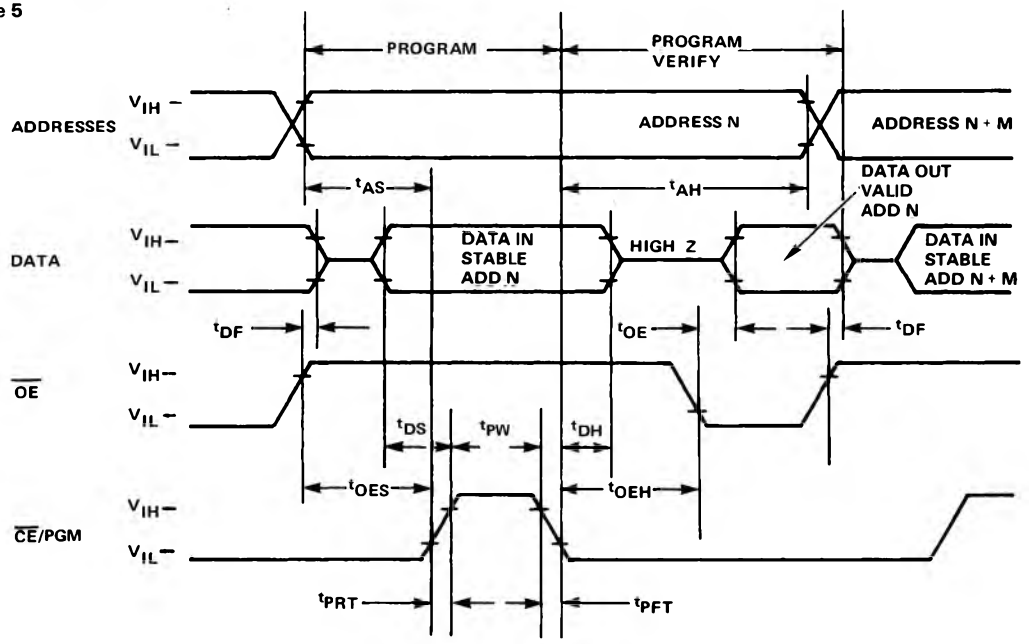
($T_A$ = 25°C ± 5°C) ($V_{CC}$ = +5 V ± 10%, $V_{PP}$ = 25 V ± 1 V)

| SYM | PARAMETER | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|
| $t_{AS}$ | Address Setup Time | 2 | | | μs | |
| $t_{OES}$ | $\overline{OE}$ Setup Time | 2 | | | μs | |
| $t_{DS}$ | Data Setup Time | 2 | | | μs | |
| $t_{AH}$ | Address Hold Time | 2 | | | μs | |
| $t_{OEH}$ | $\overline{OE}$ Hold Time | 2 | | | μs | |
| $t_{DH}$ | Data Hold Time | 2 | | | μs | |
| $t_{DF}$ | Output Enable to Output Float | 0 | | 130 | ns | 4 |
| $t_{OE}$ | Output Enable to Output Delay | | | 120 | ns | 4 |
| $t_{PW}$ | Program Pulse Width | 45 | 50 | 55 | ms | |
| $t_{PRT}$ | Program Pulse Rise Time | 5 | | | ns | |
| $t_{PFT}$ | Program Pulse Fall Time | 5 | | | ns | |

**PROGRAM OPERATION NOTES:**

1. $V_{CC}$ must be applied at the same time or before $V_{PP}$ and removed after or at the same time as $V_{PP}$. To prevent damage to the device it must not be inserted into a board with $V_{PP}$ at 25 V.
2. Care must be taken to prevent overshoot of the $V_{PP}$ supply when switching to +25 V.
3. 0.45 V ≤ $V_{IN}$ ≤ 5.50 V
4. $\overline{CE}$/PGM = $V_{IL}$.
5. $\overline{CE}$/PGM = $V_{IH}$.
6. $t_T$ = 20 nsec.
7. 1 V and 2 V for inputs and .8 V and 2 V for outputs are used as timing reference levels.
8. Although speed selections are made for read operation all programming specifications are the same for all dash numbers.

## TIMING DIAGRAM
**(Program Mode)**
Figure 5




## MODE SELECTION

| | Pin: | | | |
|---|---|---|---|---|
| Mode | $\overline{CE}$/PGM (18) | $\overline{OE}$ (20) | $V_{PP}$ (21) | Output |
| Read | $V_{IL}$ | $V_{IL}$ | +5 | Valid Out |
| Standby | $V_{IH}$ | Don't Care | +5 | Open |
| Program | Pulsed $V_{IL}$ to $V_{IH}$ | $V_{IH}$ | +25 | Data Inputs |
| Program Verify | $V_{IL}$ | $V_{IL}$ | +25 | Valid Out |
| Program Inhibit | $V_{IL}$ | $V_{IH}$ | +25 | Open |
| $V_{CC}$ (24) = 5 V all modes | | | | |

## DESCRIPTION (Continued)

be done at any individual word address, sequencially or at random. The three-state output controlled by the $\overline{OE}$ input allows OR-tie capability for construction of large arrays. A single power supply requirement of +5 volts makes the MKB2716 ideally suited for use with Mostek's 5-volt only microprocessors such as the MKB3880 (Z80). The MKB2716 is packaged in the industry standard 24-pin dual-in-line package with a transparent, hermetically sealed lid. This allows the user to expose the chip to ultraviolet light to erase the data pattern. A new pattern may then be written into the device by following the program procedures outlined in this data sheet.

The MKB2716 is specifically designed to fit those applications where fast turnaround time and pattern experimentation are required. Since data may be altered in the device (erase and reprogram) it allows for early debugging of the system program. Since single location programming is available the MKB2716 can have its data content increased (assuming all 2048 bytes were not programmed) at any time for easy updating of system capabilities in the field. Once the contents become fixed and the system enters production, mask programmable ROMs can offer speed, cost per bit and power per bit benefits. Mostek offers the MKB36000 and MKB37000 8 K x 8 ROMs which allow the user to quadruple memory density in the application. A "ROM Programming Guide" is available to aid the user in preparing the code for submission once prototyping with MKB2716s has verified its accuracy.

## READ OPERATION

The MKB2716 has five basic modes of operation. Under normal operating conditions (non-programming) there are two modes; READ and STANDBY. A READ operation is accomplished by maintaining pin 18 ($\overline{CE}$) at $V_{IL}$ and pin 21 ($V_{PP}$) at +5 volts. If $\overline{OE}$ (pin 20) is held active low after addressing ($A_0$ - $A_{10}$ have stabilized) then valid output data will appear on the output pins at access time $t_{ACC}$ (address

access). In this mode, access time may be referenced to $\overline{OE}$ ($t_{OE}$) depending on when $\overline{OE}$ occurs (see timing diagrams).

POWER DOWN operation is accomplished in STANDBY mode by taking pin 18 ($\overline{CE}$) to a TTL high level ($V_{IH}$). The power is reduced by 75% from 633 mW maximum to 165 mW. During power down $V_{PP}$ must be at +5 volts, and the outputs will be open-circuit regardless of the condition of $\overline{OE}$. Access time from a high to low transition of $\overline{CE}$ ($t_{CE}$) is the same as from addresses ($t_{ACC}$). (See STANDBY Timing Diagram).

## PROGRAMMING INSTRUCTIONS

The MKB2716 is shipped from Mostek completely erased. In this initial state, and after any subsequent erasure, all bits will be at a '1' level (output high). Information is introduced by selectively programming '0's into the proper bit locations. Once a '0' has been programmed into the chip it may be changed only by erasing the entire chip with UV light.

The MKB2716 is put into the PROGRAM mode by maintaining $V_{PP}$ at +25 V, and $\overline{OE}$ at $V_{IH}$. In this mode the output pins serve as inputs (8 bits in parallel) for the required program data. Word address selection is done the same as in the READ mode, and logic levels for other inputs and the $V_{CC}$ supply voltage are the same as in the READ mode.

To program a "byte" (8 bits) of data, a TTL active high level pulse is applied to the $\overline{CE}$/PGM pin after address inputs and data have stabilized. Each location to be programmed must have a pulse applied, and only one pulse per location is required. Any individual location, a sequence of locations or locations at random may be programmed in this manner. (The program pulse has a maximum width of 55 msec, and programming must not be attempted with a high level D.C. signal applied to the $\overline{CE}$/PGM pin.)

PROGRAM INHIBIT is another useful mode of operation when programming multiple, parallel addressed MKB2716's with different data. It is necessary only to maintain $\overline{OE}$ at $V_{IH}$, $V_{PP}$ at +25, allow addresses and data to stabilize, and pulse the $\overline{CE}$/PGM pin of the device to be programmed. The devices with $\overline{CE}$/PGM at $V_{IL}$ will not be programmed. Data may then be changed and the next device pulsed.

PROGRAM VERIFY allows the MKB2716 program data to be verified without having to reduce $V_{PP}$ from +25 V to +5 V. $V_{PP}$ = 25 V should only be used in the PROGRAM, PROGRAM INHIBIT and PROGRAM VERIFY modes and must be at +5 V in all other modes.

## MKB2716 ERASING PROCEDURE

The MKB2716 may be erased by exposure to high intensity ultraviolet light, illuminating the chip through the transparent window. This exposure to ultraviolet light induces the flow of a photo current from the floating gate, thereby discharging the gate to its initial state. An ultraviolet source of 2537Å yielding a total integrated dosage of 15 Watt-seconds/cm$^2$ is required. Note that all bits of the MKB2716 will be erased. The erasure time is approximately 15 to 20 minutes utilizing a ultra-violet lamp with a 12000 $\mu$W/CM$^2$ power rating. The lamp should be used without short wave filters, and the MKB2716 to be erased should be placed about one inch away from the lamp tubes. It should be noted that as the distance between the lamp and the chip is doubled, the exposure time required goes up by a factor of 4. The UV content of sunlight is not sufficient to provide a practical means of erasing the MKB2716. However, it is recommended that the MKB2716 not be operated or stored in direct sunlight, as the UV content of sunlight may cause erasure of some bits in a short period of time.