

4M-BIT [512K x8] CMOS OTP ROM

FEATURES

- 512K x 8 organization
- Single +5V power supply
- +12.5V programming voltage
- Fast access time: 90/100/120/150 ns
- Totally static operation
- Completely TTL compatible

- Operating current: 40mA
- Standby current: 100uA
- Package type:
 - 32 pin PDIP
 - 32 pin PLCC
 - 32 pin SOP
 - 32 pin TSOP

GENERAL DESCRIPTION

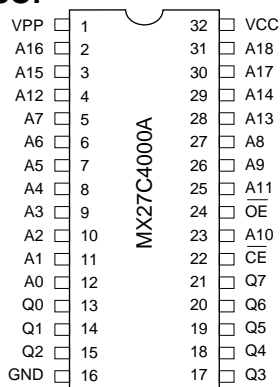
The MX27C4000A is a 5V only, 4M-bit, One Time Programmable Read Only Memory. It is organized as 512K words by 8 bits per word, operates from a single +5 volt supply, has a static standby mode, and features fast single address location programming. All programming signals are TTL levels, requiring a single pulse. For programming outside from the system, existing EPROM

programmers may be used. The MX27C4000A supports a intelligent fast programming algorithm which can result in programming time of less than two minutes.

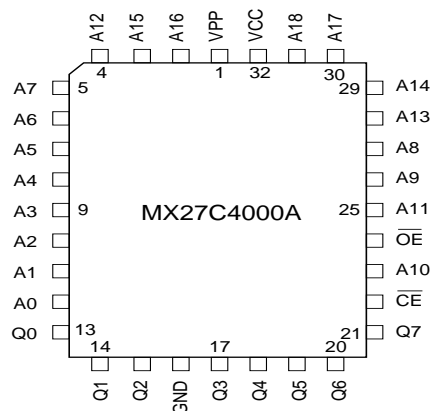
This One Time Programmable Read Only Memory is packaged in industry standard 32 pin dual-in-line plastic, 32 lead PLCC, 32 lead SOP, 32 lead TSOP packages.

PIN CONFIGURATIONS

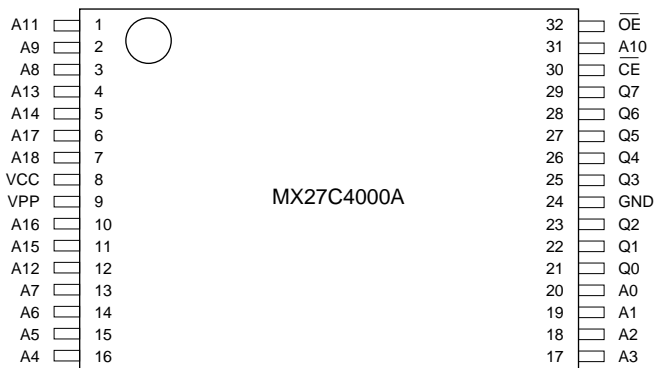
32 PDIP/SOP



32 PLCC



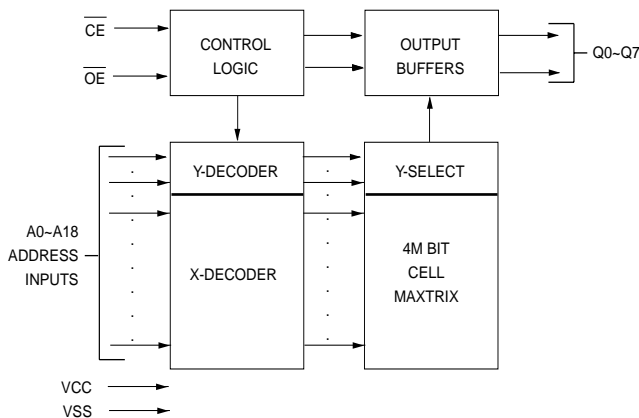
32 TSOP



PIN DESCRIPTION

| SYMBOL | PIN NAME |
|--------|------------------------|
| A0~A18 | Address Input |
| Q0~Q7 | Data Input/Output |
| CE | Chip Enable Input |
| OE | Output Enable Input |
| VPP | Program Supply Voltage |
| VCC | Power Supply Pin (+5V) |
| GND | Ground Pin |

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

THE PROGRAMMING OF THE MX27C4000A

When the MX27C4000A is delivered, or it is erased, the chip has all 4M bits in the "ONE" or HIGH state. "ZEROS" are loaded into the MX27C4000A through the procedure of programming.

For programming, the data to be programmed is applied with 8 bits in parallel to the data pins.

Vcc must be applied simultaneously or before Vpp, and removed simultaneously or after Vpp. When programming an MXIC OTP ROM, a 01uF capacitor is required across Vpp and ground to suppress spurious voltage transients which may damage the device.

FAST PROGRAMMING

The device is set up in the fast programming mode when the programming voltage $V_{PP} = 12.75V$ is applied, with $V_{CC} = 6.25V$ and $\overline{OE} = V_{IH}$ (Algorithm is shown in Figure 1). The programming is achieved by applying a single TTL low level 10us pulse to the CE input after addresses and data line are stable. If the data is not verified, an additional pulse is applied for a maximum of 25 pulses. This process is repeated while sequencing through each address of the device. When the programming mode is completed, the data in all address is verified at $V_{CC} = V_{PP} = 5V \pm 10\%$.

PROGRAM INHIBIT MODE

Programming of multiple MX27C4000As in parallel with different data is also easily accomplished by using the Program Inhibit Mode. Except for \overline{CE} and \overline{OE} , all like inputs of the parallel MX27C4000A may be common. A TTL low-level program pulse applied to an MX27C4000A \overline{CE} input with $V_{PP} = 12.5 \pm 0.5V$ and \overline{CE} LOW will program that MX27C4000A. A high-level \overline{CE} input inhibits the other MX27C4000As from being programmed.

PROGRAM VERIFY MODE

Verification should be performed on the programmed bits to determine that they were correctly programmed. The verification should be performed with \overline{OE} and \overline{CE} at VIL, and VPP at its programming voltage.

AUTO IDENTIFY MODE

The auto identify mode allows the reading out of a binary code from an OTP ROM that will identify its manufacturer and device type. This mode is intended for use by programming equipment for the purpose of automatically matching the device to be programmed with its corresponding programming algorithm. This mode is functional in the $25^{\circ}C \pm 5^{\circ}C$ ambient temperature range that is required when programming the MX27C4000A.

To activate this mode, the programming equipment must force $12.0 \pm 0.5V$ on address line A9 of the device. Two identifier bytes may then be sequenced from the device outputs by toggling address line A0 from VIL to VIH. All other address lines must be held at VIL during auto identify mode.

Byte 0 (A0 = VIL) represents the manufacturer code, and byte 1 (A0 = VIH), the device identifier code. For the MX27C4000A, these two identifier bytes are given in the Mode Select Table. All identifiers for manufacturer and device codes will possess odd parity, with the MSB (Q7) defined as the parity bit.

READ MODE

The MX27C4000A has two control functions, both of which must be logically satisfied in order to obtain data

at the outputs. Chip Enable (\overline{CE}) is the power control and should be used for device selection. Output Enable (\overline{OE}) is the output control and should be used to gate data to the output pins, independent of device selection. Assuming that addresses are stable, address access time (t_{ACC}) is equal to the delay from \overline{CE} to output (t_{CE}). Data is available at the outputs t_{OE} after the falling edge of \overline{OE} 's, assuming that \overline{CE} has been LOW and addresses have been stable for at least $t_{ACC} - t_{OE}$.

STANDBY MODE

The MX27C4000A has a CMOS standby mode which reduces the maximum VCC current to 100 μ A. It is placed in CMOS standby when \overline{CE} is at $V_{CC} \pm 0.3$ V. The MX27C4000A also has a TTL-standby mode which reduces the maximum VCC current to 1.5 mA. It is placed in TTL-standby when \overline{CE} is at V_{IH} . When in standby mode, the outputs are in a high-impedance state, independent of the \overline{OE} input.

TWO-LINE OUTPUT CONTROL FUNCTION

To accommodate multiple memory connections, a two-line control function is provided to allow for:

1. Low memory power dissipation,

2. Assurance that output bus contention will not occur.

It is recommended that \overline{CE} be decoded and used as the primary device-selecting function, while \overline{OE} be made a common connection to all devices in the array and connected to the READ line from the system control bus. This assures that all deselected memory devices are in their low-power standby mode and that the output pins are only active when data is desired from a particular memory device.

SYSTEM CONSIDERATIONS

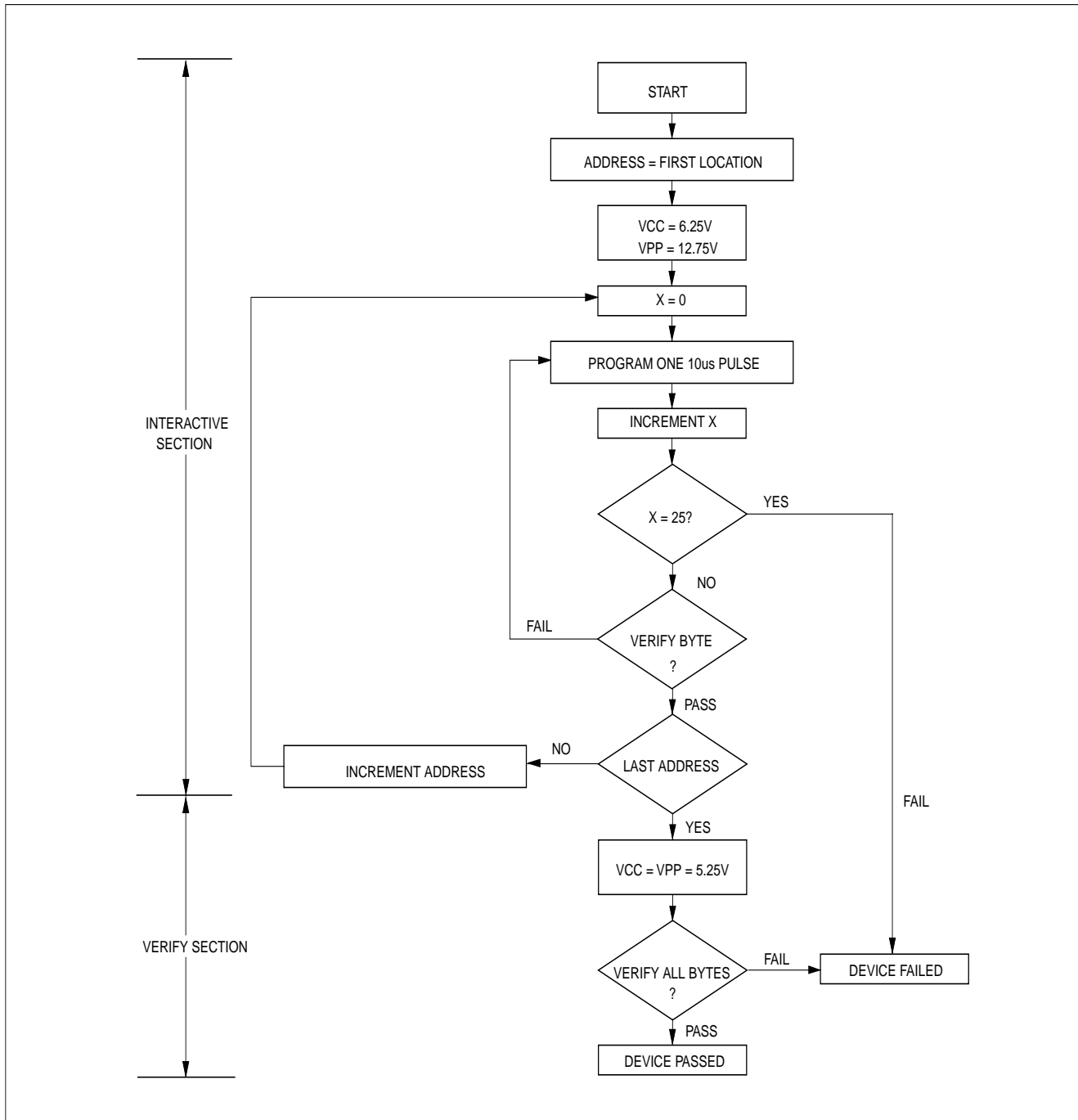
During the switch between active and standby conditions, transient current peaks are produced on the rising and falling edges of Chip Enable. The magnitude of these transient current peaks is dependent on the output capacitance loading of the device. At a minimum, a 0.1 μ F ceramic capacitor (high frequency, low inherent inductance) should be used on each device between VCC and GND to minimize transient effects. In addition, to overcome the voltage drop caused by the inductive effects of the printed circuit board traces on EPROM arrays, a 4.7 μ F bulk electrolytic capacitor should be used between VCC and GND for each eight devices. The location of the capacitor should be close to where the power supply is connected to the array.

MODE SELECT TABLE

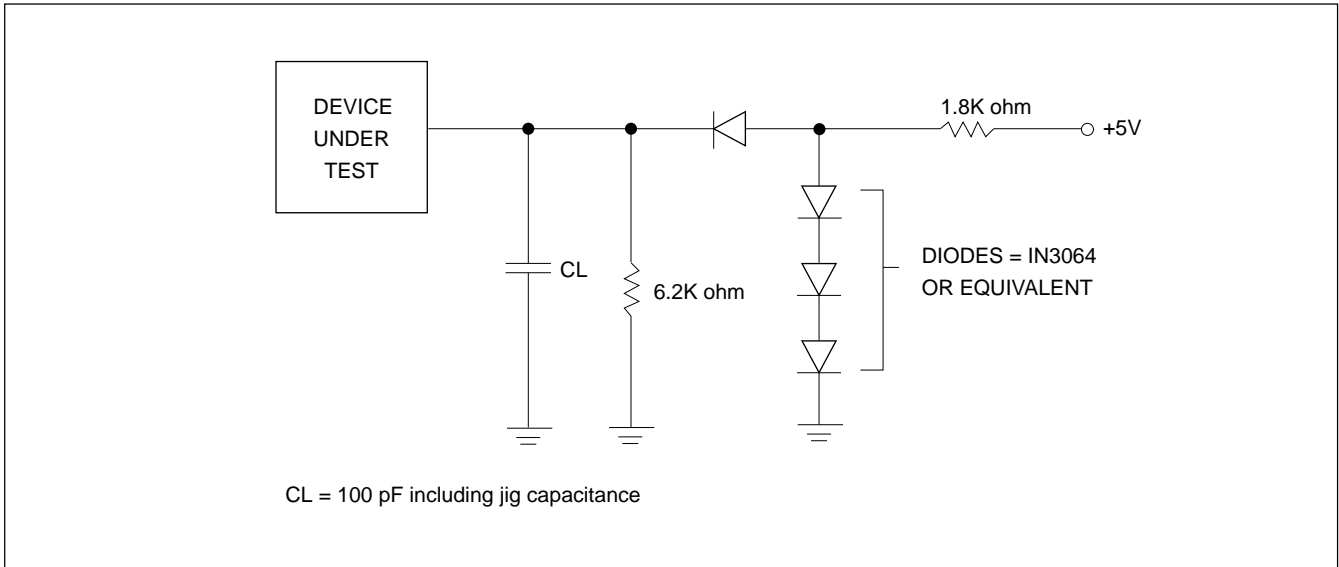
| MODE | PINS | | | | | |
|----------------------|-------------------|-----------------|-----|----|-----|---------|
| | \overline{CE} | \overline{OE} | A0 | A9 | VPP | OUTPUTS |
| Read | VIL | VIL | X | X | VCC | DOUT |
| Output Disable | VIL | VIH | X | X | VCC | High Z |
| Standby (TTL) | VIH | X | X | X | VCC | High Z |
| Standby (CMOS) | $V_{CC} \pm 0.3V$ | X | X | X | VCC | High Z |
| Program | VIL | VIH | X | X | VPP | DIN |
| Program Verify | VIH | VIL | X | X | VPP | DOUT |
| Program Inhibit | VIH | VIH | X | X | VPP | High Z |
| Manufacturer Code(3) | VIL | VIL | VIL | VH | VCC | C2H |
| Device Code(3) | VIL | VIL | VIH | VH | VCC | C0H |

NOTES:

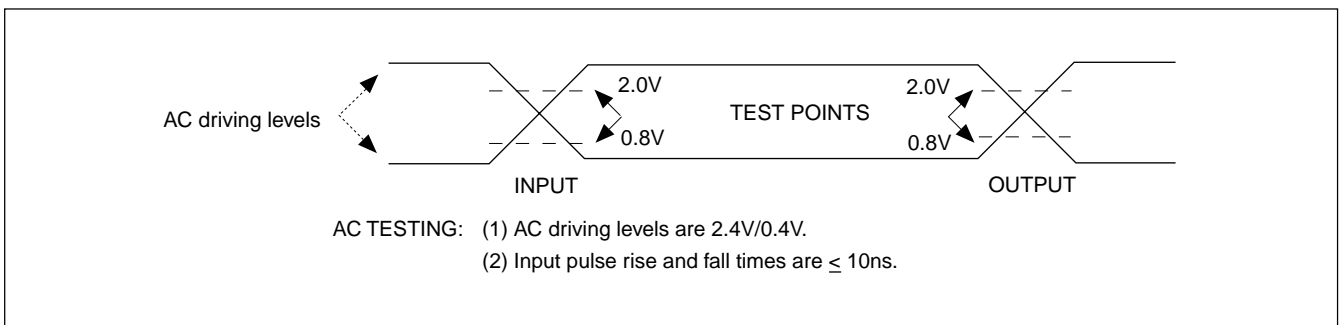
1. $V_H = 12.0$ V \pm 0.5 V
2. X = Either V_{IH} or V_{IL}
3. A1 - A8 = A10 - A18 = VIL (For auto select)
4. See DC Programming Characteristics for VPP voltage during programming.

FIGURE 1. FAST PROGRAMMING FLOWCHART


SWITCHING TEST CIRCUITS



SWITCHING TEST WAVEFORMS



ABSOLUTE MAXIMUM RATINGS

| RATING | VALUE |
|-------------------------------|---------------------|
| Ambient Operating Temperature | -40°C to 85°C |
| Storage Temperature | -65°C to 125°C |
| Applied Input Voltage | -0.5V to 7.0V |
| Applied Output Voltage | -0.5V to VCC + 0.5V |
| VCC to Ground Potential | -0.5V to 7.0V |
| A9 & VPP | -0.5V to 13.5V |

NOTICE:

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 this specification is not implied. Exposure to absolute maximum rating conditions for extended period may affect reliability.

NOTICE:

Specifications contained within the following tables are subject to change.

DC/AC OPERATING CONDITION FOR READ OPERATION

| | | MX27C4000A | | | |
|-----------------------|------------|---------------|---------------|---------------|---------------|
| | | -90 | -10 | -12 | -15 |
| Operating Temperature | Industrial | -40°C to 85°C | -40°C to 85°C | -40°C to 85°C | -40°C to 85°C |
| Vcc Power Supply | | 5V ± 10% | 5V ± 10% | 5V ± 10% | 5V ± 10% |

DC CHARACTERISTICS

| SYMBOL | PARAMETER | MIN. | MAX. | UNIT | CONDITIONS |
|--------|-------------------------|------|-----------|------|---|
| VOH | Output High Voltage | 2.4 | | V | IOH = -0.4mA |
| VOL | Output Low Voltage | | 0.4 | V | IOL = 2.1mA |
| VIH | Input High Voltage | 2.0 | VCC + 0.5 | V | |
| VIL | Input Low Voltage | -0.3 | 0.8 | V | |
| ILI | Input Leakage Current | -10 | 10 | uA | VIN = 0 to 5.5V |
| ILO | Output Leakage Current | -10 | 10 | uA | VOUT = 0 to 5.5V |
| ICC3 | VCC Power-Down Current | | 100 | uA | $\overline{CE} = VCC \pm 0.3V$ |
| ICC2 | VCC Standby Current | | 1.5 | mA | $\overline{CE} = VIH$ |
| ICC1 | VCC Active Current | | 40 | mA | $\overline{CE} = VIL, f=5MHz, I_{out} = 0mA$ |
| IPP | VPP Supply Current Read | | 10 | uA | $\overline{CE} = \overline{OE} = VIL, VPP = 5.5V$ |

CAPACITANCE TA = 25°C, f = 1.0 MHz (Sampled only)

| SYMBOL | PARAMETER | TYP. | MAX. | UNIT | CONDITIONS |
|--------|--------------------|------|------|------|------------|
| CIN | Input Capacitance | 8 | 15 | pF | VIN = 0V |
| COUT | Output Capacitance | 8 | 15 | pF | VOUT = 0V |
| CVPP | VPP Capacitance | 18 | 25 | pF | VPP = 0V |



AC CHARACTERISTICS

| Symbol | PARAMETER | 27C4000A-90 | | 27C4000A-10 | | 27C4000A-12 | | 27C4000A-15 | | Unit | Conditions |
|--------|---|-------------|------|-------------|------|-------------|------|-------------|------|------|--|
| | | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. | MAX. | | |
| tACC | Address to Output Delay | | 90 | | 100 | | 120 | | 150 | ns | $\overline{CE}=\overline{OE}=\text{VIL}$ |
| tCE | Chip Enable to Output Delay | | 90 | | 100 | | 120 | | 150 | ns | $\overline{OE}=\text{VIL}$ |
| tOE | Output Enable to Output Delay | | 40 | | 45 | | 50 | | 65 | ns | $\overline{CE}=\text{VIL}$ |
| tDF | \overline{OE} High to Output Float, or \overline{CE} High to Output Float | 0 | 30 | 0 | 30 | 0 | 35 | 0 | 50 | ns | |
| tOH | Output Hold from Address, \overline{CE} or \overline{OE} which ever occurred first | | 0 | | 0 | | 0 | | 0 | ns | |

DC PROGRAMMING CHARACTERISTICS $T_A = 25^\circ\text{C} \pm 5^\circ\text{C}$

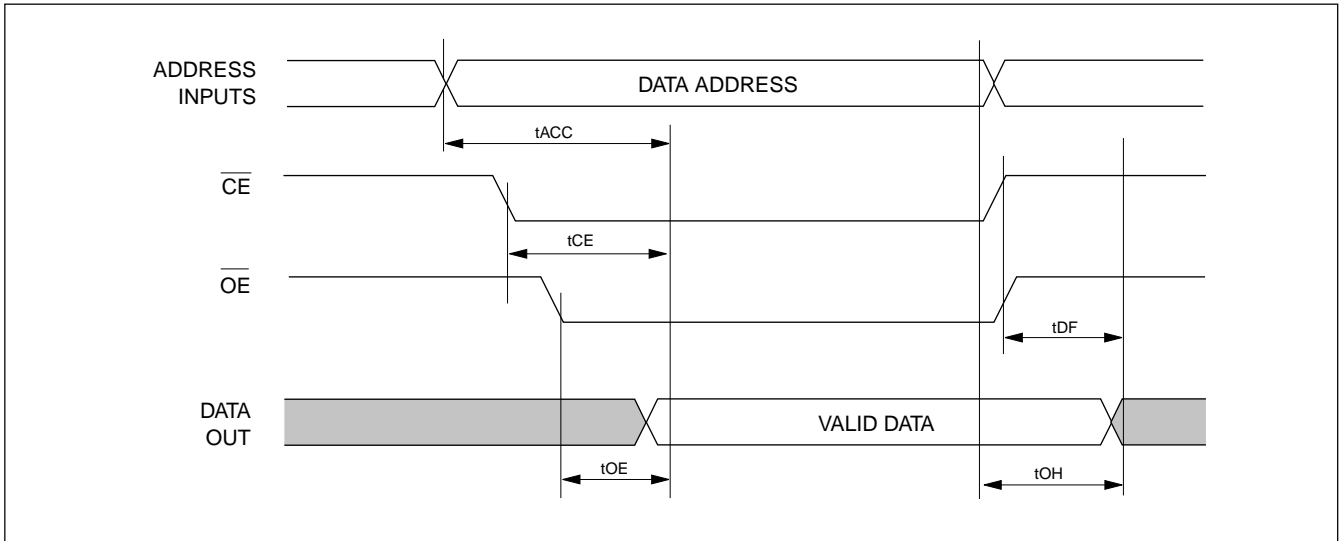
| SYMBOL | PARAMETER | MIN. | MAX. | UNIT | CONDITIONS |
|--------|---------------------------------------|------|-----------|------|--|
| VOH | Output High Voltage | 2.4 | | V | IOH = -0.40mA |
| VOL | Output Low Voltage | | 0.4 | V | IOL = 2.1mA |
| VIH | Input High Voltage | 2.0 | VCC + 0.5 | V | |
| VIL | Input Low Voltage | -0.3 | 0.8 | V | |
| ILI | Input Leakage Current | -10 | 10 | uA | VIN = 0 to 5.5V |
| VH | A9 Auto Select Voltage | 11.5 | 12.5 | V | |
| ICC3 | VCC Supply Current (Program & Verify) | | 50 | mA | |
| IPP2 | VPP Supply Current(Program) | | 30 | mA | $\overline{CE} = \text{VIL}, \overline{OE} = \text{VIH}$ |
| VCC1 | Fast Programming Supply Voltage | 6.00 | 6.50 | V | |
| VPP1 | Fast Programming Voltage | 12.5 | 13.0 | V | |

AC PROGRAMMING CHARACTERISTICS $T_A = 25^\circ\text{C} \pm 5^\circ\text{C}$

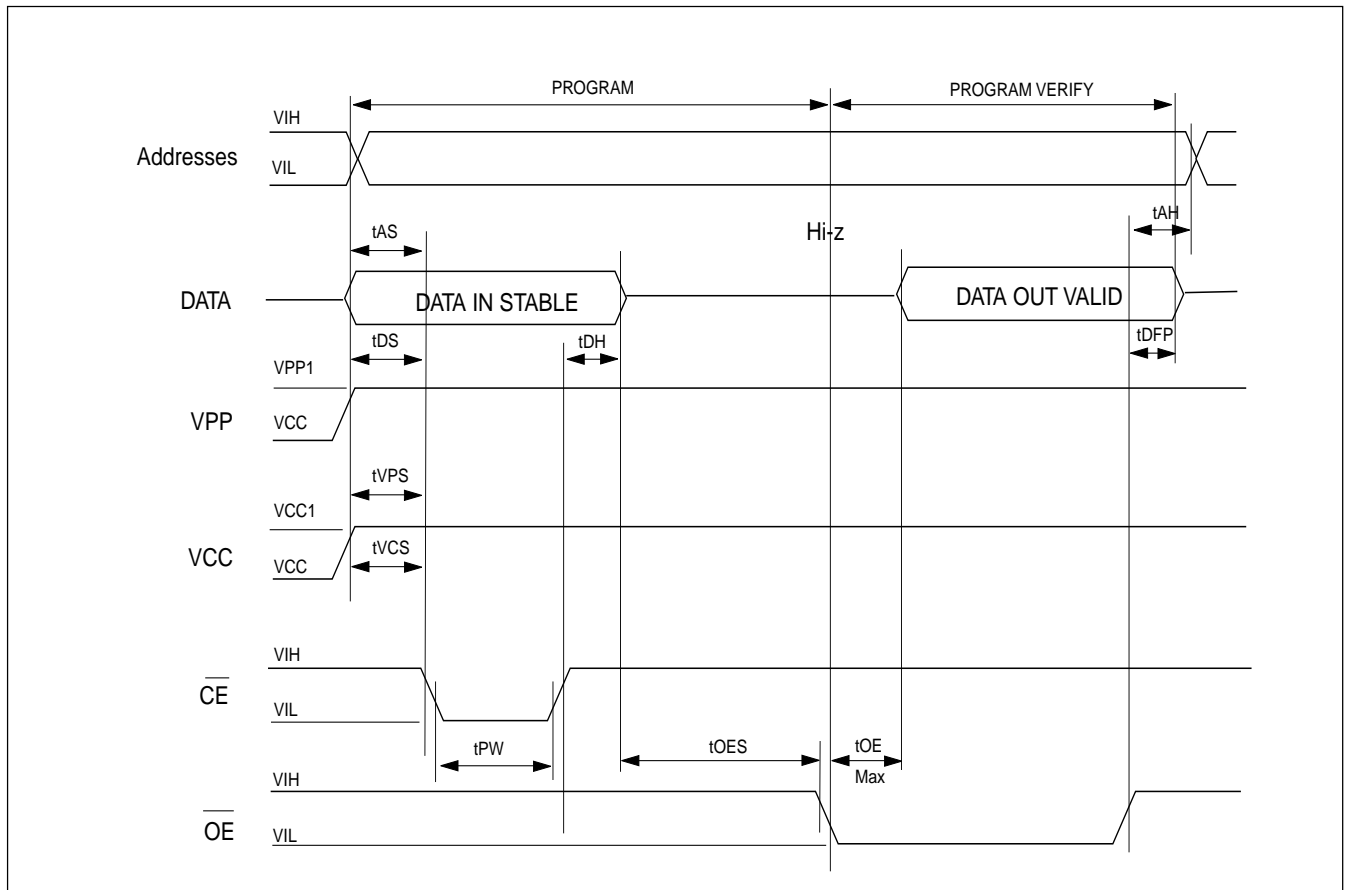
| SYMBOL | PARAMETER | MIN. | MAX. | UNIT | CONDITIONS |
|--------|---|------|------|------|------------|
| tAS | Address Setup Time | 2.0 | | us | |
| tOES | \overline{OE} Setup Time | 2.0 | | us | |
| tDS | Data Setup Time | 2.0 | | us | |
| tAH | Address Hold Time | 0 | | us | |
| tDH | Data Hold Time | 2.0 | | us | |
| tDFP | Output Enable to Output Float Delay | 0 | 130 | ns | |
| tVPS | VPP Setup Time | 2.0 | | us | |
| tPW | $\overline{\text{PGM}}$ Program Pulse Width | 10 | 50 | us | |
| tVCS | VCC Setup Time | 2.0 | | us | |
| tOE | Data valid from \overline{OE} | | 150 | ns | |

WAVEFORMS

READ CYCLE



FAST PROGRAMMING ALGORITHM WAVEFORM





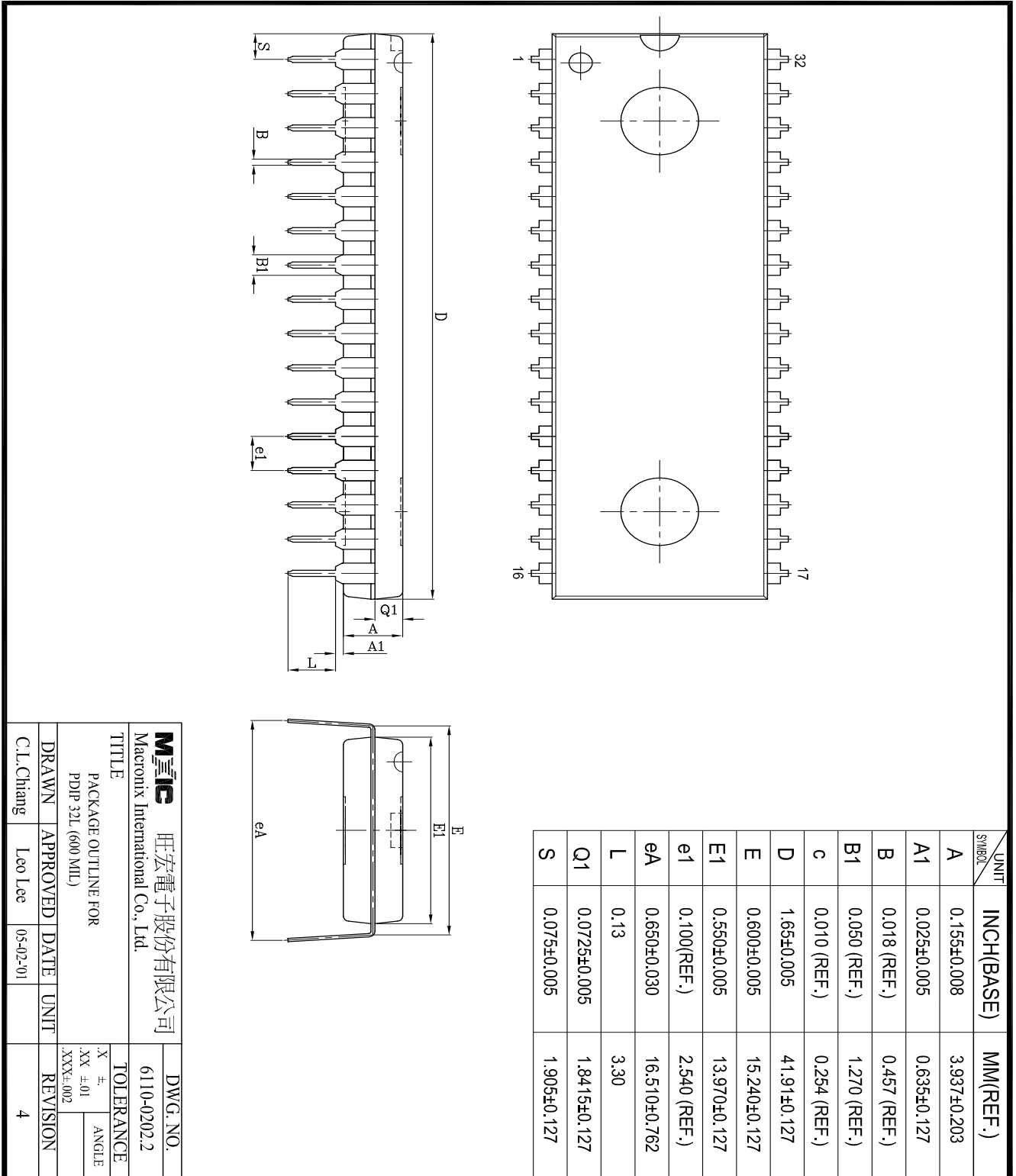
ORDERING INFORMATION

PLASTIC PACKAGE

| PART NO. | ACCESS TIME | OPERATING | STANDBY | OPERATING | PACKAGE |
|-----------------|-------------|------------------|------------------|---------------|-------------|
| | (ns) | Current MAX.(mA) | Current MAX.(uA) | TEMPERATURE | |
| MX27C4000APC-90 | 90 | 30 | 100 | 0°C to 70°C | 32 Pin DIP |
| MX27C4000AQC-90 | 90 | 30 | 100 | 0°C to 70°C | 32 Pin PLCC |
| MX27C4000AMC-90 | 90 | 30 | 100 | 0°C to 70°C | 32 Pin SOP |
| MX27C4000ATC-90 | 90 | 30 | 100 | 0°C to 70°C | 32 Pin TSOP |
| MX27C4000APC-10 | 100 | 30 | 100 | 0°C to 70°C | 32 Pin DIP |
| MX27C4000AQC-10 | 100 | 30 | 100 | 0°C to 70°C | 32 Pin PLCC |
| MX27C4000AMC-10 | 100 | 30 | 100 | 0°C to 70°C | 32 Pin SOP |
| MX27C4000ATC-10 | 100 | 30 | 100 | 0°C to 70°C | 32 Pin TSOP |
| MX27C4000APC-12 | 120 | 30 | 100 | 0°C to 70°C | 32 Pin DIP |
| MX27C4000AQC-12 | 120 | 30 | 100 | 0°C to 70°C | 32 Pin PLCC |
| MX27C4000AMC-12 | 120 | 30 | 100 | 0°C to 70°C | 32 Pin SOP |
| MX27C4000ATC-12 | 120 | 30 | 100 | 0°C to 70°C | 32 Pin TSOP |
| MX27C4000APC-15 | 150 | 30 | 100 | 0°C to 70°C | 32 Pin DIP |
| MX27C4000AQC-15 | 150 | 30 | 100 | 0°C to 70°C | 32 Pin PLCC |
| MX27C4000AMC-15 | 150 | 30 | 100 | 0°C to 70°C | 32 Pin SOP |
| MX27C4000ATC-15 | 150 | 30 | 100 | 0°C to 70°C | 32 Pin TSOP |
| MX27C4000API-90 | 90 | 30 | 100 | -40°C to 85°C | 32 Pin DIP |
| MX27C4000AQI-90 | 90 | 30 | 100 | -40°C to 85°C | 32 Pin PLCC |
| MX27C4000AMI-90 | 90 | 30 | 100 | -40°C to 85°C | 32 Pin SOP |
| MX27C4000ATI-90 | 90 | 30 | 100 | -40°C to 85°C | 32 Pin TSOP |
| MX27C4000API-10 | 100 | 30 | 100 | -40°C to 85°C | 32 Pin DIP |
| MX27C4000AQI-10 | 100 | 30 | 100 | -40°C to 85°C | 32 Pin PLCC |
| MX27C4000AMI-10 | 100 | 30 | 100 | -40°C to 85°C | 32 Pin SOP |
| MX27C4000ATI-10 | 100 | 30 | 100 | -40°C to 85°C | 32 Pin TSOP |
| MX27C4000API-12 | 120 | 30 | 100 | -40°C to 85°C | 32 Pin DIP |
| MX27C4000AQI-12 | 120 | 30 | 100 | -40°C to 85°C | 32 Pin PLCC |
| MX27C4000AMI-12 | 120 | 30 | 100 | -40°C to 85°C | 32 Pin SOP |
| MX27C4000ATI-12 | 120 | 30 | 100 | -40°C to 85°C | 32 Pin TSOP |
| MX27C4000API-15 | 150 | 30 | 100 | -40°C to 85°C | 32 Pin DIP |
| MX27C4000AQI-15 | 150 | 30 | 100 | -40°C to 85°C | 32 Pin PLCC |
| MX27C4000AMI-15 | 150 | 30 | 100 | -40°C to 85°C | 32 Pin SOP |
| MX27C4000ATI-15 | 150 | 30 | 100 | -40°C to 85°C | 32 Pin TSOP |

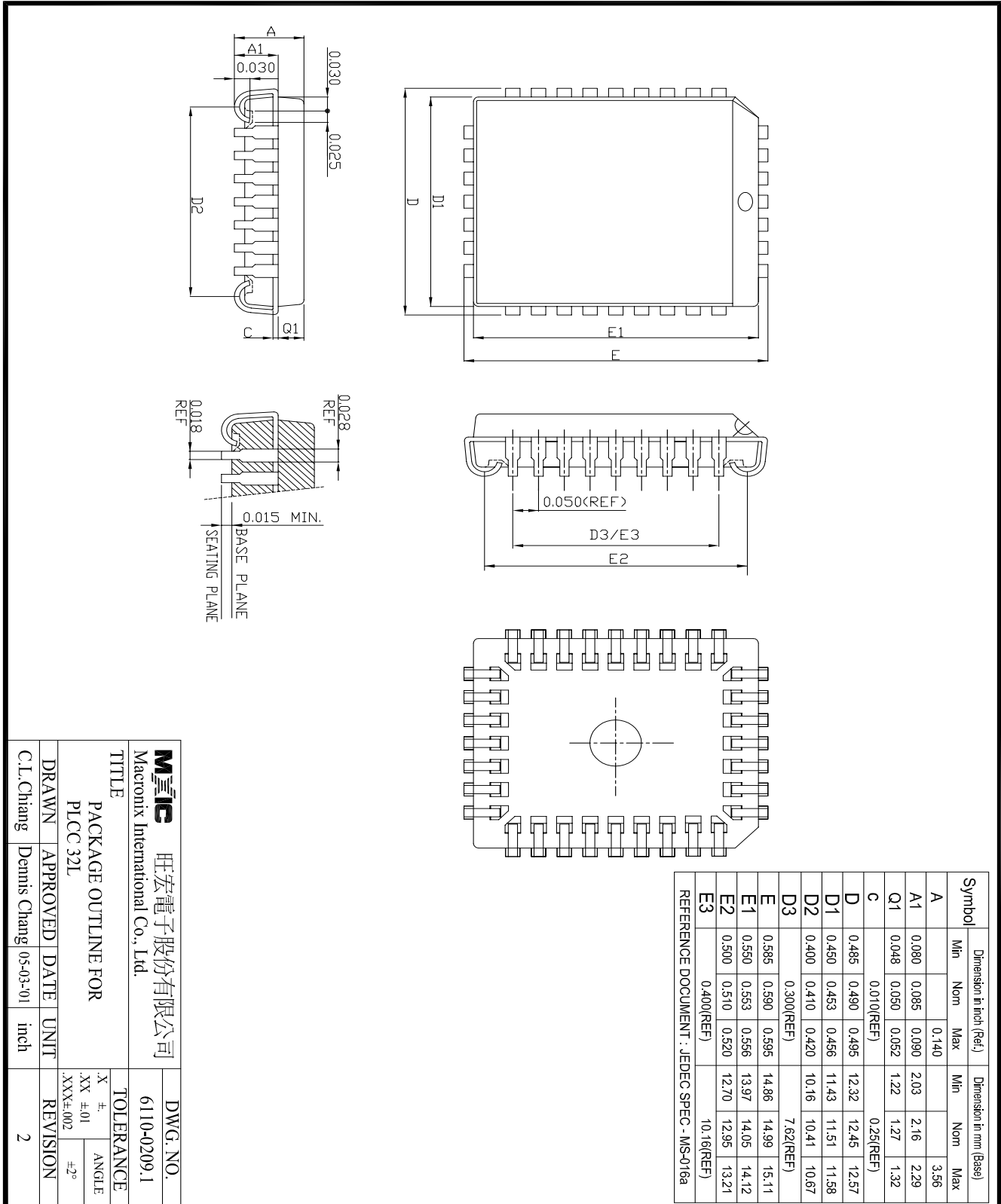
PACKAGE INFORMATION

32-PIN PLASTIC DIP(600 mil)



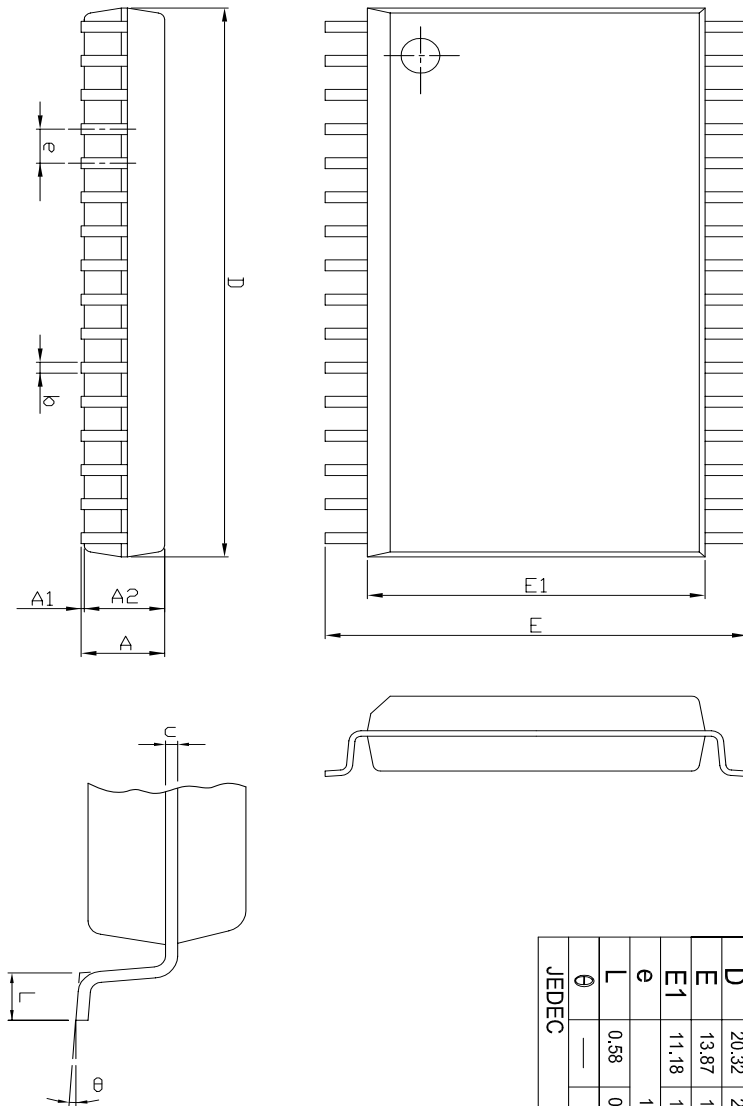
| | | | |
|---|----------|-----------|-------------|
| 旺宏電子股份有限公司 Macronix International Co., Ltd. | | DWG. NO. | 6110-0202.2 |
| TITLE | | TOLERANCE | |
| PACKAGE OUTLINE FOR | | X ±. | ANGLE |
| PDDP 32L (600 MIL) | | XX ±.01 | |
| | | .XXX±.002 | |
| DRAWN | APPROVED | DATE | UNIT |
| C.L.Chang | Leo Lee | 05-02-01 | |
| | | REVISION | 4 |

32-PIN PLASTIC LEADED CHIP CARRIER (PLCC)



| | | | |
|--|--------------|-------------------------|------|
| Mxic 旺宏電子股份有限公司 Macronix International Co., Ltd. | | DWG. NO. 6110-0209.1 | |
| TITLE PACKAGE OUTLINE FOR PLCC 32L | | | |
| DRAWN | APPROVED | DATE | UNIT |
| C.L.Chang | Dennis Chang | 05-03-'01 | inch |
| TOLERANCE | | REVISION | |
| X ± XX ±.01 .XXX±.002 | | 2 | |
| ANGLE ±2° | | | |

32-PIN PLASTIC SOP (450 mil)

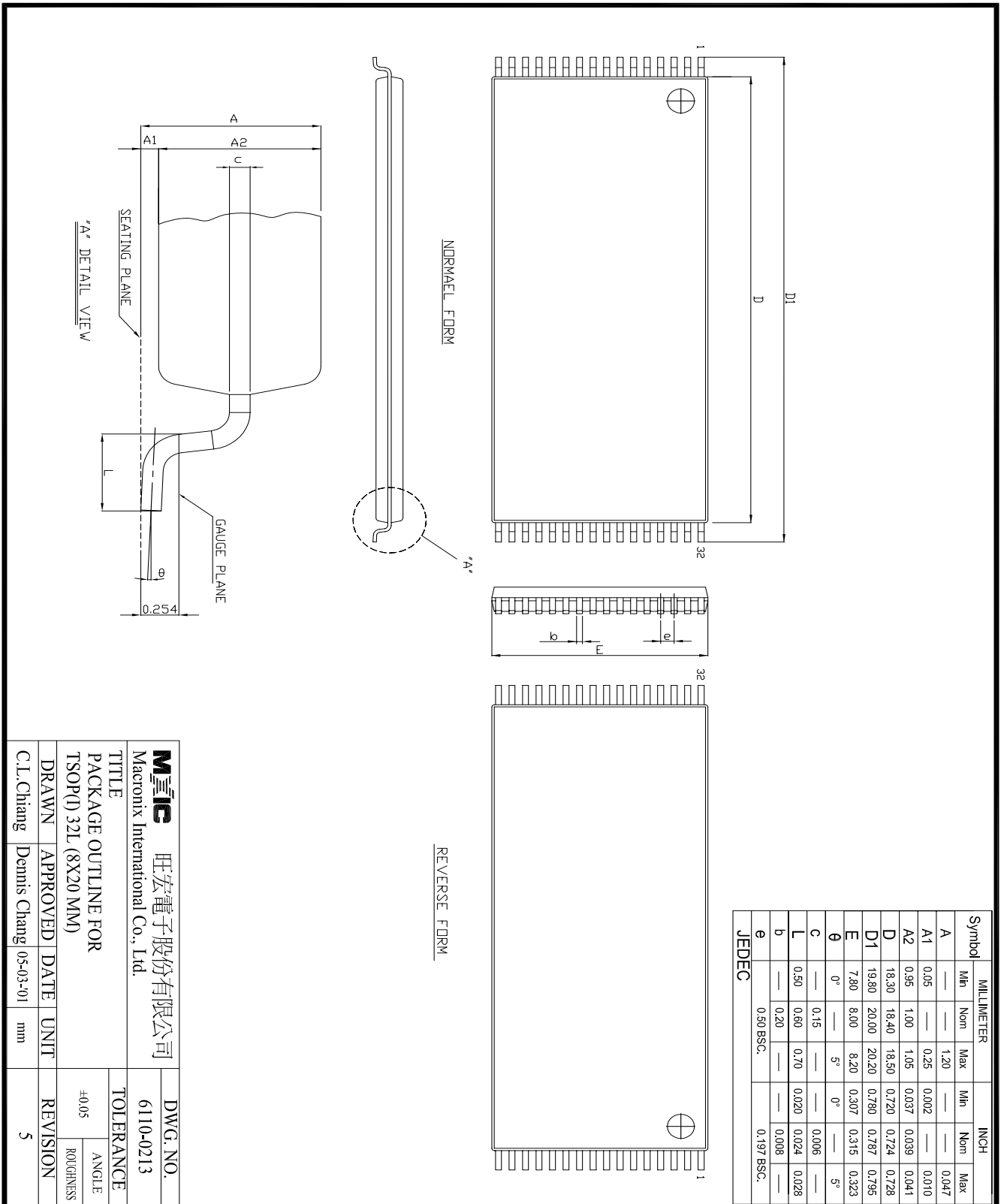


| Symbol | Dimension in mm (Base) | | | Dimension in inch (Ref.) | | |
|--------|------------------------|-------|-------|--------------------------|-------|-------|
| | Min | Nom | Max | Min | Nom | Max |
| A | — | — | 3.00 | — | — | 0.118 |
| A1 | 0.10 | — | — | 0.004 | — | — |
| A2 | 2.57 | 2.69 | 2.82 | 0.101 | 0.106 | 0.111 |
| b | 0.41 REF | | | 0.016 REF | | |
| C | 0.20 REF | | | 0.008 REF | | |
| D | 20.32 | 20.45 | 20.57 | 0.800 | 0.805 | 0.810 |
| E | 13.87 | 14.12 | 14.38 | 0.546 | 0.556 | 0.566 |
| E1 | 11.18 | 11.30 | 11.43 | 0.440 | 0.445 | 0.450 |
| e | 1.27 REF | | | 0.050 REF | | |
| L | 0.58 | 0.79 | 0.99 | 0.023 | 0.031 | 0.039 |
| phi | — | 5° | — | — | 5° | — |

JEDEC

| | | | |
|---|--------------|-----------|------|
| Mxic 旺宏電子股份有限公司 | | DWG. NO. | |
| Macronix International Co., Ltd. | | 6110-0206 | |
| TITLE PACKAGE OUTLINE FOR SOP 32L (450 MIL) | | | |
| DRAWN | APPROVED | DATE | UNIT |
| C.L. Chiang | Dennis Chang | 05-03-01 | INCH |
| TOLERANCE | | REVISION | |
| X ± | ANGLE | 2 | |
| XX ±.01 | ROUGHNESS | | |
| XXX±.002 | | | |

32-PIN PLASTIC TSOP



| | | | |
|----------------------------------|--|------------------------|--|
| Mxic 旺宏電子股份有限公司 | | DWG. NO. | |
| Macronix International Co., Ltd. | | 6110-0213 | |
| TITLE | | TOLERANCE | |
| PACKAGE OUTLINE FOR | | ±0.05 | |
| TSOP(I) 32L (8X20 MM) | | ANGLE | |
| DRAWN | | REVISION | |
| APPROVED | | 5 | |
| DATE | | REVISION | |
| UNIT | | 5 | |
| mm | | 5 | |
| C.I. Chiang | | Dennis Chang 05-03-'01 | |

REVISION HISTORY

| Revision No. | Description | Page | Date |
|---------------------|---|----------------------------|-------------|
| 1.1 | Modify Fast Programming Flowchart--Program One 100us Pulse -->10us Pulse | P4 | JUL/06/2000 |
| 1.2 | Modify AC Programming Characteristics--tPW 95-->10(MIN.) Cencel 150ns speed Add "Advance Information" | P7 P1,5,6,7,10 P1 | JUL/13/2000 |
| 1.3 | Add tPW(MAX.):50us | P7 | SEP/01/2000 |
| 1.4 | Modify Absolute Naximum Ratings--Ambient Operation Temperature 0°C to 70°C --> -40°C to 85°C Add Package type: 32PLCC Add Order Information--> -40°C to 85°C Operating Temperature Del Fast access time:100ns | P6 P1,9 P9 P1,6,7 | SEP/08/2000 |
| 1.5 | To added access time 100/150ns and 32SOP/TSOP type package To changed ID Code from 41H to C0H | P1,6,7,9,11 P3 | MAR/19/2001 |
| 1.6 | To modify Package Information | P10~13 | JUL/19/2001 |



MX27C4000A

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