

**MAXIM**  
**Complete, 12-Bit**  
**Voltage-Output DACs**

### General Description

The MX7245/MX7248 are complete, 12-bit digital-to-analog converters (DACs) that include an internal voltage reference and a voltage-output amplifier. The MX7245/MX7248 are pin and electrically compatible with Analog Devices' AD7245/AD7248.

The MX7245/MX7248 have double-buffered logic interfaces that are easily interfaced to microprocessors ( $\mu$ Ps). Data is transferred into the Input register from a 12-bit-wide data bus (MX7245) for 16-bit  $\mu$ Ps, or in a right-justified (8+4)-bit format (MX7248) for 8- and 16-bit  $\mu$ Ps. All logic signals are level triggered and are TTL and CMOS compatible. The timing specifications ensure compatibility with common  $\mu$ Ps.

The DACs are specified and tested for both dual- and single-supply operation. Usable supplies range from single +12V to dual  $\pm 15$ V.

Internal gain-setting resistors allow three output voltage ranges: 0V to +5V and 0V to +10V can be generated using either single or dual supplies. With dual supplies, an additional output range of  $\pm 5$ V is available. The output amplifier drives  $2\text{k}\Omega$  loads to +10V.

See MAX507/MAX508 data sheet for detailed description.

## Applications

## Minimum Component Count Analog Systems

## Digital Offset and Gain Adjustment

Industrial Control

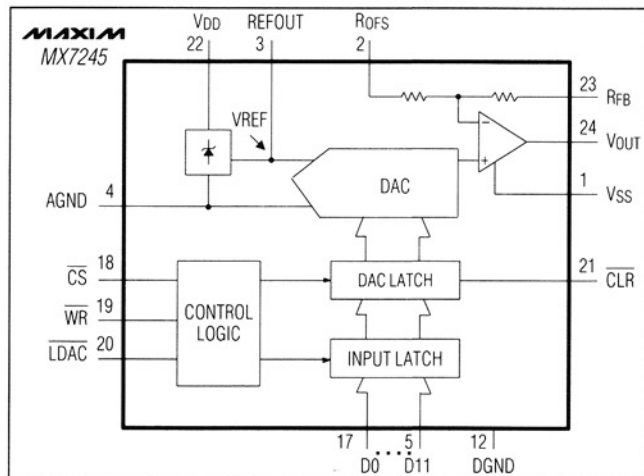
## Arbitrary Function Generators

## Automatic Test Equipment

## Automated Calibration

Machine and Motion Control

### Functional Diagram



## Features

- ◆ 12-Bit Voltage Output
- ◆ Low-Noise, Buried-Zener Voltage Reference
- ◆ Fast Logic Interface (80ns  $\overline{WR}$  Pulse)
- ◆ Operate from Single or Dual Supplies
- ◆ 8-/16-Bit Microprocessor-Bus Compatible
- ◆ Available in DIP and PLCC Packages
- ◆ Pin and Electrically Compatible with AD7245/AD7248

## Ordering Information

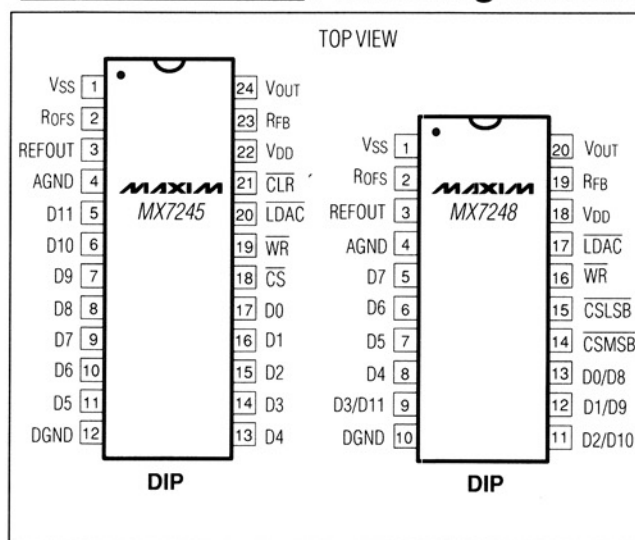
| PART      | TEMP. RANGE     | PIN-PACKAGE    |
|-----------|-----------------|----------------|
| MX7245JN  | 0°C to +70°C    | 24 Plastic DIP |
| MX7245JP  | 0°C to +70°C    | 28 PLCC        |
| MX7245J/D | 0°C to +70°C    | Dice*          |
| MX7245AQ  | -40°C to +85°C  | 24 CERDIP      |
| MX7245SE  | -55°C to +125°C | 28 LCC**       |
| MX7245SQ  | -55°C to +125°C | 24 CERDIP**    |
| MX7248JN  | 0°C to +70°C    | 20 Plastic DIP |
| MX7248JP  | 0°C to +70°C    | 20 PLCC        |
| MX7248J/D | 0°C to +70°C    | Dice*          |
| MX7248AE  | -40°C to +85°C  | 20 LCC***      |
| MX7248AQ  | -40°C to +85°C  | 20 CERDIP      |
| MX7248SE  | -55°C to +125°C | 20 LCC**       |
| MX7248SQ  | -55°C to +125°C | 20 CERDIP**    |

\* Contact factory for dice specifications.

**\*\*** Contact factory for availability and processing to MIL-STD-883.

\*\*\*Contact factory for availability.

## Pin Configurations



**MX7245/MX7248**

# Complete, 12-Bit Voltage-Output DACs

## ABSOLUTE MAXIMUM RATINGS

|                                            |                                   |
|--------------------------------------------|-----------------------------------|
| V <sub>DD</sub> to AGND                    | -0.3V, +17V                       |
| V <sub>DD</sub> to DGND                    | -0.3V, +17V                       |
| V <sub>DD</sub> to V <sub>SS</sub>         | -0.3V, +34V                       |
| AGND to DGND                               | -0.3V, V <sub>DD</sub>            |
| Digital Input Voltage to GND               | -0.3V, V <sub>DD</sub> + 0.3V     |
| V <sub>OUT</sub> to AGND (Note 1)          | V <sub>SS</sub> , V <sub>DD</sub> |
| REFOUT to AGND (Note 1)                    | -0.3V, V <sub>DD</sub> + 0.3V     |
| Continuous Power Dissipation (any package) |                                   |
| to +75°C                                   | .450mW                            |
| derate above +75°C by                      | 6mW/°C                            |

Operating Temperature Ranges:

|                                      |                 |
|--------------------------------------|-----------------|
| MX724_J_                             | 0°C to +70°C    |
| MX724_A_                             | -40°C to +85°C  |
| MX724_S_                             | -55°C to +125°C |
| Storage Temperature Range            | -65°C to +160°C |
| Lead Temperature (soldering, 10 sec) | +300°C          |

**Note 1:** The output can be shorted to either supply rail if the package power dissipation is not exceeded. Typical short-circuit current to AGND is 25mA.

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

Single Supply (V<sub>DD</sub> = +11.4V to +15.75V, V<sub>SS</sub> = AGND = DGND = 0V, R<sub>L</sub> = 2kΩ, C<sub>L</sub> = 100pF, REFOUT unloaded, all grades, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

| PARAMETER                                          | SYMBOL           | CONDITIONS                                            | MIN  | TYP | MAX          | UNITS         |
|----------------------------------------------------|------------------|-------------------------------------------------------|------|-----|--------------|---------------|
| <b>STATIC PERFORMANCE</b>                          |                  |                                                       |      |     |              |               |
| Resolution                                         | N                |                                                       | 12   |     |              | Bits          |
| Relative Accuracy                                  | INL              |                                                       |      |     | ±1           | LSB           |
| Differential Nonlinearity                          | DNL              |                                                       |      |     | ±1           | LSB           |
| Unipolar Offset Error                              | UOE              | T <sub>A</sub> = +25°C                                |      |     | ±3           | LSB           |
|                                                    |                  | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      |     | ±5           |               |
| DAC Gain Error                                     |                  |                                                       |      |     | ±2           | LSB           |
| Full-Scale Output Voltage Error                    | FSE              | V <sub>DD</sub> = 12V or 15V                          |      |     | ±0.2         | % of FSR      |
|                                                    |                  |                                                       |      |     | ±0.6         |               |
| ΔFull-Scale Output Voltage Error/ ΔV <sub>DD</sub> |                  | V <sub>DD</sub> = 12V or 15V ±5%                      |      |     | ±0.12        | % of FSR      |
|                                                    |                  |                                                       |      |     | ±0.2         |               |
| Full-Scale Tempco                                  |                  | MX724_J_/A_                                           |      |     | ±30          | ppm of FSR/°C |
|                                                    |                  | MX724_S_                                              |      |     | ±40          |               |
| ΔOffset/ΔV <sub>DD</sub>                           |                  | V <sub>DD</sub> = 12V or 15V ±5%                      |      |     | ±1           | mV            |
| <b>REFERENCE</b>                                   |                  |                                                       |      |     |              |               |
| Reference Output                                   |                  | V <sub>DD</sub> = 12V or 15V, T <sub>A</sub> = +25°C  | 4.99 |     | 5.01         | V             |
| ΔReference/ΔV <sub>DD</sub>                        |                  | V <sub>DD</sub> = 12V or 15V ±5%                      |      |     | 2            | mV/V          |
|                                                    |                  |                                                       |      |     | 6            |               |
| Reference Temperature Coefficient                  | TCV <sub>O</sub> | MX724_J_/A_                                           |      |     | ±30          | ppm/°C        |
|                                                    |                  | MX724_S_                                              |      |     | ±40          |               |
| Reference Load Sensitivity                         |                  | I <sub>LOAD</sub> = 0μA to 100μA                      |      |     | ±1           | mV            |
| <b>ANALOG OUTPUT</b>                               |                  |                                                       |      |     |              |               |
| Output Range Resistors                             |                  |                                                       | 15   |     | 30           | kΩ            |
| Ranges                                             |                  | (Note 2)                                              |      |     | 0 to 5 or 10 | V             |
| DC Output Impedance                                |                  |                                                       |      | 0.5 |              | Ω             |
| Short-Circuit Current                              |                  |                                                       |      | 25  |              | mA            |

# Complete, 12-Bit Voltage-Output DACs

MX7245/MX7248

## ELECTRICAL CHARACTERISTICS (continued)

Single Supply ( $V_{DD} = +11.4V$  to  $+15.75V$ ,  $V_{SS} = AGND = DGND = 0V$ ,  $R_L = 2k\Omega$ ,  $C_L = 100pF$ ,  $REFOUT$  unloaded, all grades,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

| PARAMETER                           | SYMBOL | CONDITIONS                        | MIN                          | TYP | MAX   | UNITS     |
|-------------------------------------|--------|-----------------------------------|------------------------------|-----|-------|-----------|
| <b>DYNAMIC PERFORMANCE</b> (Note 3) |        |                                   |                              |     |       |           |
| Output Voltage Settling Time        | $t_s$  | Settling time to $\pm 1/2LSB$     |                              |     | 5     | $\mu s$   |
| Output Voltage Slew Rate            |        |                                   | 2                            |     |       | $V/\mu s$ |
| Digital Feedthrough                 |        |                                   |                              | 10  |       | $nV-s$    |
| Digital-to-Analog Glitch Impulse    | Q      | Major carry transition            |                              | 30  |       | $nV-s$    |
| Output Load Resistance              |        | $V_{OUT} = 0V$ to $+10V$ (Note 2) | 2                            |     |       | $k\Omega$ |
| <b>POWER SUPPLIES</b>               |        |                                   |                              |     |       |           |
| $V_{DD}$ Range                      |        | For specified performance         | 11.40                        |     | 15.75 | V         |
| $I_{DD}$                            |        | Outputs unloaded                  | $T_A = +25^\circ C$          |     | 9     | mA        |
|                                     |        |                                   | $T_A = T_{MIN}$ to $T_{MAX}$ |     | 12    |           |

## ELECTRICAL CHARACTERISTICS

Dual Supply ( $V_{DD} = +11.4V$  to  $+15.75V$ ,  $V_{SS} = -11.4V$  to  $-15.75V$ ,  $DGND = AGND = 0V$ ,  $R_L = 2k\Omega$ ,  $C_L = 100pF$ ,  $REFOUT$  unloaded, all grades,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

| PARAMETER                                                 | SYMBOL | CONDITIONS                                    | MIN                          | TYP      | MAX        | UNITS                  |
|-----------------------------------------------------------|--------|-----------------------------------------------|------------------------------|----------|------------|------------------------|
| <b>STATIC PERFORMANCE</b>                                 |        |                                               |                              |          |            |                        |
| Resolution                                                | N      |                                               | 12                           |          |            | Bits                   |
| Relative Accuracy                                         | INL    |                                               |                              |          | $\pm 1$    | LSB                    |
| Differential Nonlinearity                                 | DNL    |                                               |                              |          | $\pm 1$    | LSB                    |
| Bipolar Zero Offset Error                                 | BZOE   | $T_A = +25^\circ C$                           |                              |          | $\pm 3$    | LSB                    |
|                                                           |        | $T_A = T_{MIN}$ to $T_{MAX}$                  |                              |          | $\pm 5$    |                        |
| DAC Gain Error                                            |        |                                               |                              |          | $\pm 2$    | LSB                    |
| Full-Scale Output Voltage Error                           | FSE    | $V_{DD} = 15V$ or $-15V$                      | $T_A = +25^\circ C$          |          | $\pm 0.2$  | % of FSR               |
|                                                           |        |                                               | $T_A = T_{MIN}$ to $T_{MAX}$ |          | $\pm 0.6$  |                        |
|                                                           |        | $V_{DD} = 12V$ or $-12V$                      | $T_A = +25^\circ C$          |          | $\pm 0.2$  |                        |
|                                                           |        |                                               | $T_A = T_{MIN}$ to $T_{MAX}$ |          | $\pm 0.6$  |                        |
| $\Delta$ Full-Scale Output Voltage Error/ $\Delta V_{DD}$ |        | $V_{DD} = 12V$ or $15V \pm 5\%$               | $T_A = +25^\circ C$          |          | $\pm 0.12$ | % of FSR               |
|                                                           |        |                                               | $T_A = T_{MIN}$ to $T_{MAX}$ |          | $\pm 0.2$  |                        |
| $\Delta$ Full-Scale Output Voltage Error/ $\Delta V_{SS}$ |        | $V_{SS} = 12V$ or $15V \pm 5\%$               |                              |          | $\pm 1$    | mV                     |
| Full-Scale Tempco                                         |        | MX724_J_/A_                                   |                              |          | $\pm 30$   | ppm of FSR/ $^\circ C$ |
|                                                           |        | MX724_S_                                      |                              |          | $\pm 40$   |                        |
| $\Delta$ Offset/ $\Delta V_{DD}$                          |        | $V_{DD} = 12V$ or $15V \pm 5\%$               |                              |          | $\pm 1$    | mV                     |
| <b>REFERENCE</b>                                          |        |                                               |                              |          |            |                        |
| Reference Output                                          |        | $V_{DD} = 12V$ or $15V$ , $T_A = +25^\circ C$ | 4.99                         |          | 5.01       | V                      |
| $\Delta$ Reference/ $\Delta V_{DD}$                       |        | $V_{DD} = 12V$ or $15V \pm 5\%$               | $T_A = +25^\circ C$          |          | 2          | mV/V                   |
|                                                           |        |                                               | $T_A = T_{MIN}$ to $T_{MAX}$ |          | 6          |                        |
| Reference Temperature Coefficient                         | TCVO   | MX724_J_/A_                                   |                              | $\pm 30$ |            | ppm/ $^\circ C$        |
|                                                           |        | MX724_S_                                      |                              | $\pm 40$ |            |                        |
| Reference Load Sensitivity                                |        | $I_{LOAD} = 0\mu A$ to $100\mu A$             |                              |          | $\pm 1$    | mV                     |

# Complete, 12-Bit Voltage-Output DACs

## ELECTRICAL CHARACTERISTICS (continued)

Dual Supply ( $V_{DD} = +11.4V$  to  $+15.75V$ ,  $V_{SS} = -11.4V$  to  $-15.75V$ ,  $DGND = AGND = 0V$ ,  $R_L = 2k\Omega$ ,  $C_L = 100pF$ ,  $REF_{OUT}$  unloaded, all grades,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

| PARAMETER                           | SYMBOL | CONDITIONS                    | MIN                          | TYP                     | MAX    | UNITS      |
|-------------------------------------|--------|-------------------------------|------------------------------|-------------------------|--------|------------|
| <b>ANALOG OUTPUT</b>                |        |                               |                              |                         |        |            |
| Output Range Resistors              |        |                               | 15                           |                         | 30     | $k\Omega$  |
| Ranges                              |        | (Note 2)                      |                              | 0 to 5 or 10<br>-5 to 5 |        | V          |
| DC Output Impedance                 |        |                               |                              | 0.5                     |        | $\Omega$   |
| Short-Circuit Current               |        |                               |                              | 25                      |        | mA         |
| <b>DYNAMIC PERFORMANCE</b> (Note 3) |        |                               |                              |                         |        |            |
| Output Voltage Settling Time        | $t_S$  | Settling time to $\pm 1/2LSB$ |                              |                         | 5      | $\mu s$    |
| Output Voltage Slew Rate            |        |                               | 2                            |                         |        | V/ $\mu s$ |
| Digital Feedthrough                 |        |                               |                              | 10                      |        | nV-s       |
| Digital-to-Analog Glitch Impulse    | Q      | Major carry transition        |                              | 30                      |        | nV-s       |
| Output Load Resistance              |        | $V_{OUT} = -5V$ to $+10V$     | 2                            |                         |        | $k\Omega$  |
| <b>POWER SUPPLIES</b>               |        |                               |                              |                         |        |            |
| $V_{DD}$ Range                      |        | For specified performance     | 11.40                        |                         | 15.75  | V          |
| $V_{SS}$ Range                      |        | For specified performance     | -11.40                       |                         | -15.75 | V          |
| $I_{DD}$                            |        | Outputs unloaded              | $T_A = +25^\circ C$          |                         | 9      | mA         |
|                                     |        |                               | $T_A = T_{MIN}$ to $T_{MAX}$ |                         | 12     |            |
| $I_{SS}$                            |        | Outputs unloaded              | $T_A = +25^\circ C$          |                         | 3      | mA         |
|                                     |        |                               | $T_A = T_{MIN}$ to $T_{MAX}$ |                         | 5      |            |

## ELECTRICAL CHARACTERISTICS

Single or Dual Supply ( $V_{DD} = +11.4V$  to  $+15.75V$ ,  $V_{SS} = 0V$  to  $-15.75V$ ,  $DGND = AGND = 0V$ ,  $R_L = 2k\Omega$ ,  $C_L = 100pF$ ,  $REF_{OUT}$  unloaded, all grades,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

| PARAMETER                 | SYMBOL    | CONDITIONS                                                 | MIN                          | TYP | MAX      | UNITS   |
|---------------------------|-----------|------------------------------------------------------------|------------------------------|-----|----------|---------|
| <b>DIGITAL INPUTS</b>     |           |                                                            |                              |     |          |         |
| Input High Voltage        | $V_{INH}$ |                                                            | 2.4                          |     |          | V       |
| Input Low Voltage         | $V_{INL}$ |                                                            |                              |     | 0.8      | V       |
| Input Current             | $I_{IN}$  | D0-D11                                                     | $T_A = +25^\circ C$          |     | $\pm 1$  | $\mu A$ |
|                           |           |                                                            | $T_A = T_{MIN}$ to $T_{MAX}$ |     | $\pm 10$ |         |
|                           | $I_{INH}$ | $\overline{CS}$ , $WR$ , $LDAC$ , $CLR$ , $CSMB$ , $CSLSB$ | $T_A = +25^\circ C$          |     | $\pm 1$  |         |
|                           |           |                                                            | $T_A = T_{MIN}$ to $T_{MAX}$ |     | $\pm 10$ |         |
|                           | $I_{INL}$ | $\overline{CS}$ , $WR$ , $LDAC$ , $CLR$ , $CSMB$ , $CSLSB$ | $T_A = +25^\circ C$          |     | 150      |         |
|                           |           |                                                            | $T_A = T_{MIN}$ to $T_{MAX}$ |     | 200      |         |
| Digital Input Capacitance | $C_{IN}$  | MX7245                                                     |                              |     | 8        | pF      |
|                           |           | MX7248                                                     |                              |     | 16       |         |

**Note 2:**  $V_{OUT}$  must be less than  $(V_{DD} - 2.5V)$ .

**Note 3:** Guaranteed at  $T_A = +25^\circ C$ , but not production tested.

# Complete, 12-Bit Voltage-Output DACs

MX7245/MX7248

## SWITCHING CHARACTERISTICS

( $T_A = T_{MIN} = T_{MAX}$ , unless otherwise noted.)

| PARAMETER                                     | SYMBOL                 | CONDITIONS                          | J GRADE |     | A GRADE |     | S GRADE |     | UNITS |
|-----------------------------------------------|------------------------|-------------------------------------|---------|-----|---------|-----|---------|-----|-------|
|                                               |                        |                                     | MIN     | MAX | MIN     | MAX | MIN     | MAX |       |
| $\overline{CS}$ Pulse Width                   | $t_1$                  | $T_A = +25^\circ\text{C}$           | 80      |     | 80      |     | 105     |     | ns    |
|                                               |                        | $T_A = T_{MIN} \text{ to } T_{MAX}$ | 100     |     | 100     |     | 135     |     |       |
| $\overline{WR}$ Pulse Width                   | $t_2$                  | $T_A = +25^\circ\text{C}$           | 80      |     | 80      |     | 105     |     | ns    |
|                                               |                        | $T_A = T_{MIN} \text{ to } T_{MAX}$ | 100     |     | 100     |     | 135     |     |       |
| $\overline{CS}$ to $\overline{WR}$ Setup Time | $t_3$                  |                                     | 0       |     | 0       |     | 0       |     | ns    |
| $\overline{CS}$ to $\overline{WR}$ Hold Time  | $t_4$                  |                                     | 0       |     | 0       |     | 0       |     | ns    |
| Data to $\overline{WR}$ Setup Time            | $t_5$<br>(MX7245 only) | $T_A = +25^\circ\text{C}$           | 100     |     | 100     |     | 155     |     | ns    |
|                                               |                        | $T_A = T_{MIN} \text{ to } T_{MAX}$ | 110     |     | 130     |     | 250     |     |       |
|                                               | $t_5$<br>(MX7248 only) | $T_A = +25^\circ\text{C}$           | 110     |     | 110     |     | 180     |     |       |
|                                               |                        | $T_A = T_{MIN} \text{ to } T_{MAX}$ | 130     |     | 130     |     | 270     |     |       |
| Data to $\overline{WR}$ Hold Time             | $t_6$<br>(MX7245 only) |                                     | 10      |     | 10      |     | 10      |     | ns    |
| $\overline{LDAC}$ Pulse Width                 | $t_7$                  | $T_A = +25^\circ\text{C}$           | 80      |     | 80      |     | 90      |     | ns    |
|                                               |                        | $T_A = T_{MIN} \text{ to } T_{MAX}$ | 100     |     | 100     |     | 120     |     |       |
| $\overline{CLR}$ Pulse Width                  | $t_8$<br>(MX7245 only) | $T_A = +25^\circ\text{C}$           | 80      |     | 80      |     | 140     |     | ns    |
|                                               |                        | $T_A = T_{MIN} \text{ to } T_{MAX}$ | 100     |     | 100     |     | 200     |     |       |

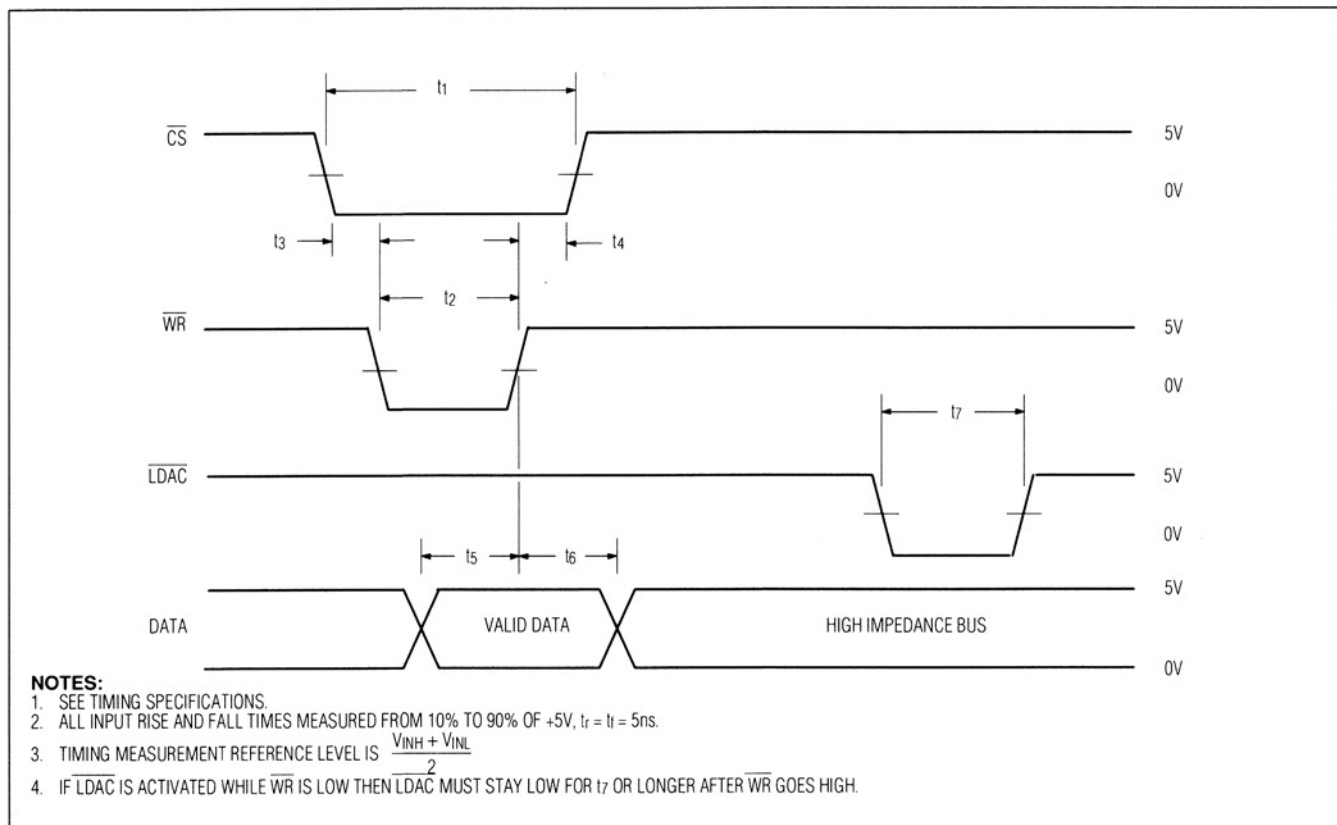


Figure 1. MX7245 Write-Cycle Timing Diagram

# Complete, 12-Bit Voltage-Output DACs

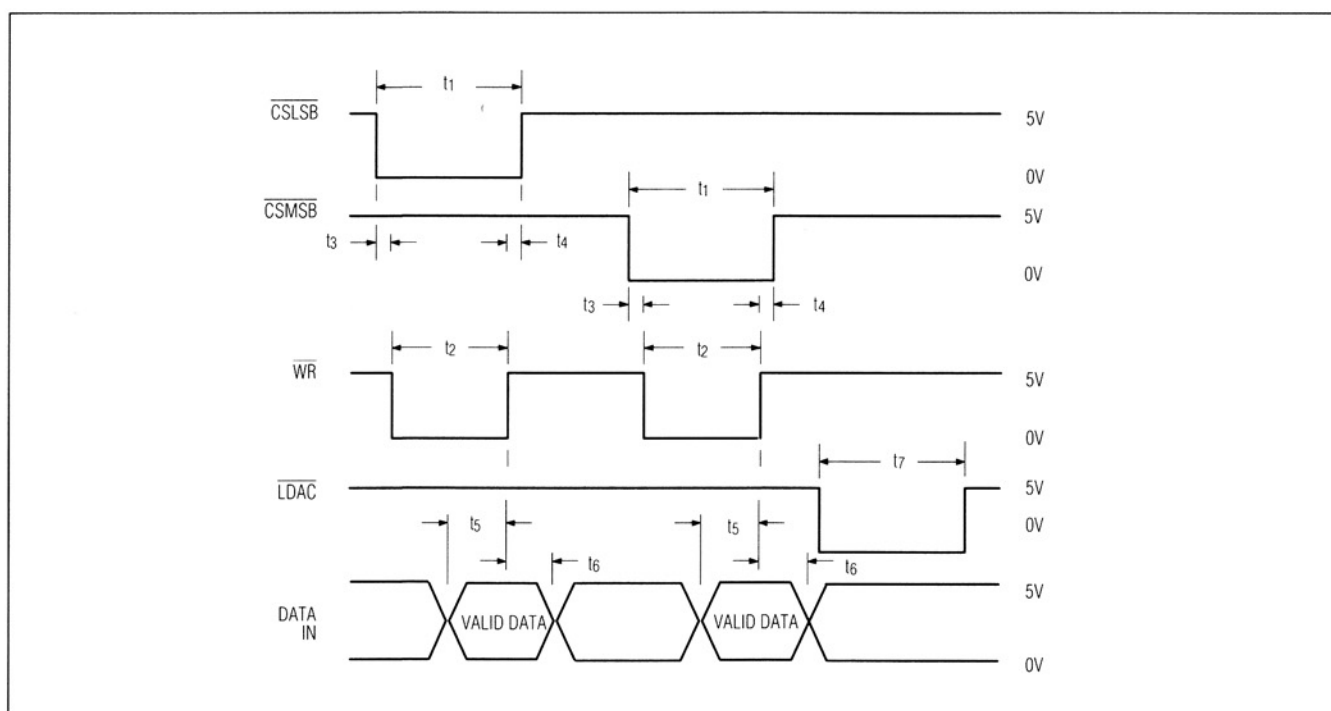


Figure 2. MX7248 Write-Cycle Timing Diagram

| MX7245<br>PIN | MX7248<br>PIN | NAME              | FUNCTION                | MX7245<br>PIN | MX7248<br>PIN | NAME             | FUNCTION                                          |
|---------------|---------------|-------------------|-------------------------|---------------|---------------|------------------|---------------------------------------------------|
| 1             | 1             | V <sub>SS</sub>   | Negative Supply Voltage | 13-17         |               | D4-D0            | Data Bits 4-0                                     |
| 2             | 2             | R <sub>OFFS</sub> | Bipolar Offset Resistor | 18            |               | CS               | Chip-Select Input - active low                    |
| 3             | 3             | REFOUT            | Reference Output        |               | 14            | C̄SMSB           | Chip-Select Input for the MSB nibble – active low |
| 4             | 4             | AGND              | Analog Ground           |               | 15            | C̄LSLB           | Chip-Select Input for the LSB byte – active low   |
|               | 5-8           | D7-D4             | Data Bits 7-4           | 19            | 16            | W̄R              | Write Input - active low                          |
|               | 9             | D3/D11            | Data Bits 3 and 11      | 20            | 17            | L̄DAC            | Load DAC Input - active low                       |
|               | 5-11          | D11-D5            | Data Bits 11-5          | 21            |               | C̄LR             | Clear Input - active low                          |
| 12            | 10            | DGND              | Digital Ground          | 22            | 18            | V <sub>DD</sub>  | Positive Supply Voltage                           |
|               | 11            | D2/D10            | Data Bits 2 and 10      | 23            | 19            | R <sub>FB</sub>  | Feedback Resistor                                 |
|               | 12            | D1/D9             | Data Bits 1 and 9       | 24            | 20            | V <sub>OUT</sub> | Output Voltage                                    |
|               | 13            | D0-D8             | Data Bits 0 and 8       |               |               |                  |                                                   |

See MAX507/MAX508 data sheet for applications information.

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