



**THE DATASHEET OF  
MX7845JP+**



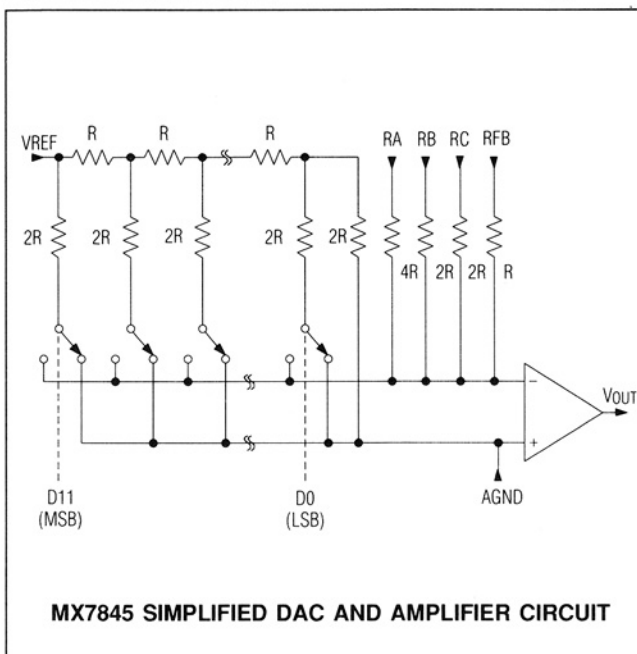
**MAXIM****Complete, 12-Bit Multiplying DAC****General Description**

The MX7845 is a 12-bit, voltage-output, 4-quadrant, multiplying digital-to-analog converter (DAC). A precision internal output amplifier and thin-film resistors, laser-trimmed at the wafer level, maintain accuracy over the full operating temperature range. The output amplifier is internally compensated and drives  $\pm 10V$  into a  $2k\Omega$  load.

The MX7845 has buffered latches that are easily interfaced with microprocessors. Data is transferred into the input register from a 12-bit-wide data path. The input registers are controlled by standard  $\overline{CS}$  (CS) and  $\overline{WR}$  (WR) signals. For stand-alone operation, the  $\overline{CS}$  and  $\overline{WR}$  inputs are grounded, making all latches transparent. All logic inputs are level-triggered and compatible with TTL and +5V CMOS logic levels. For a detailed description of MX7845 operation, refer to the MAX501/MAX502 data sheet.

**Applications**

Automatic Test Equipment  
 Digital Attenuators  
 Programmable Power Supplies  
 Programmable-Gain Amplifiers  
 Digital to 4-20mA Converters

**Functional Diagram**

**MAXIM** is a registered trademark of Maxim Integrated Products.

**Features**

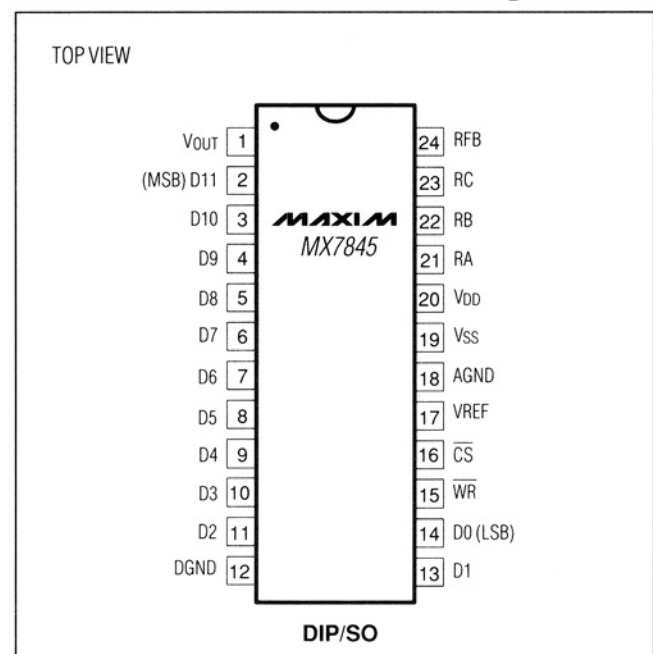
- ◆ Complete MDAC with Output Amplifier
- ◆ 4-Quadrant Multiplication
- ◆ Guaranteed Monotonic ( $T_{MIN}$  to  $T_{MAX}$ )
- ◆ Matched Application Resistors
- ◆ Small 0.3" 24-Pin DIP Package

**Ordering Information**

| PART       | TEMP. RANGE     | PIN-PACKAGE           |
|------------|-----------------|-----------------------|
| MX7845JN   | 0°C to +70°C    | 24 Narrow Plastic DIP |
| MX7845KN   | 0°C to +70°C    | 24 Narrow Plastic DIP |
| MX7845JR   | 0°C to +70°C    | 24 Wide SO            |
| MX7845KR   | 0°C to +70°C    | 24 Wide SO            |
| MX7845JP   | 0°C to +70°C    | 28 PLCC               |
| MX7845KP   | 0°C to +70°C    | 28 PLCC               |
| MX7845J/D  | 0°C to +70°C    | Dice*                 |
| MX7845AEWG | -40°C to +85°C  | 24 Wide SO            |
| MX7845BEWG | -40°C to +85°C  | 24 Wide SO            |
| MX7845AQ   | -40°C to +85°C  | 24 Narrow CERDIP      |
| MX7845BQ   | -40°C to +85°C  | 24 Narrow CERDIP      |
| MX7845SE   | -55°C to +125°C | 28 LCC**              |
| MX7845SQ   | -55°C to +125°C | 24 Narrow CERDIP**    |
| MX7845TQ   | -55°C to +125°C | 24 Narrow CERDIP**    |

\* Contact factory for dice specifications.

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

**Pin Configuration****MX7845****MAXIM**

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# Complete, 12-Bit Multiplying DAC

**MX7845**

## ABSOLUTE MAXIMUM RATINGS

|                                   |  |  |                               |
|-----------------------------------|--|--|-------------------------------|
| V <sub>DD</sub> to DGND           | -0.3V, +17V                                    | Digital Input Voltage to DGND              | -0.3V, V <sub>DD</sub> + 0.3V |
| V <sub>SS</sub> to DGND           | +0.3V, -17V                                    | Continuous Power Dissipation (any package) | 650mW                         |
| V <sub>REF</sub> to AGND          | ±25V   | to +75°C                                   | 10mW/°C                       |
| V <sub>RFB</sub> to AGND          | ±25V   | derate above +75°C                         | 10mW/°C                       |
| V <sub>RA</sub> to AGND           | ±25V   | Operating Temperature Ranges:              |                               |
| V <sub>RB</sub> to AGND           | ±25V   | MX7845J_/K_                                | 0°C to +70°C                  |
| V <sub>RC</sub> to AGND           | ±25V   | MX7845A_/B_                                | -40°C to +85°C                |
| V <sub>OUT</sub> to AGND (Note 1) | V <sub>DD</sub> + 0.3V, V <sub>SS</sub> - 0.3V | MX7845S_/T_                                | -55°C to +125°C               |
| V <sub>DD</sub> to AGND           | -0.3V, +17V                                    | Storage Temperature Range                  | -65°C to +150°C               |
| AGND to DGND                      | -0.3V, V <sub>DD</sub>                         | Lead Temperature (soldering, 10 sec)       | +300°C                        |

**Note 1:** V<sub>OUT</sub> may be shorted to AGND, V<sub>DD</sub>, or V<sub>SS</sub> if the package power dissipation is not exceeded.

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

(V<sub>DD</sub> = +15V ±5%, V<sub>SS</sub> = -15V ±5%, V<sub>REF</sub> = +10V, AGND = DGND = 0V, V<sub>OUT</sub> connected to RFB, R<sub>L</sub> = 2kΩ, C<sub>L</sub> = 100pF, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, all grades, unless otherwise noted.)

| PARAMETER                           | SYMBOL          | CONDITIONS  |             | MIN | TYP | MAX  | UNITS         |
|-------------------------------------|-----------------|---|-------------|-----|-----|------|---------------|
| <b>ACCURACY</b>                     |                 |   |             |     |     |      |               |
| Resolution                          | N               |   |             | 12  |     |      | Bits          |
| Relative Accuracy (Note 2)          | INT             | T <sub>A</sub> = +25°C                                      | MX7845K/B/T |     |     | ±1/2 | LSB           |
|                                     |                 |   | MX7845J/A/S |     |     | ±1   |               |
|                                     |                 |   | MX7845K     |     |     | ±3/4 |               |
|                                     |                 |   | MX7845J/B/T |     |     | ±1   |               |
|                                     |                 |   | MX7845A     |     |     | ±3/2 |               |
| MX7845S                             |                 |   | ±2          |     |     |      |               |
| Differential Nonlinearity           | DNL             |   |             |     |     | ±1   | LSB           |
| Zero-Code Offset Error (Note 3)     |                 | T <sub>A</sub> = +25°C                                      | MX7845K/B/T |     |     | ±1   | mV            |
|                                     |                 |   | MX7845J/A/S |     |     | ±2   |               |
|                                     |                 |   | MX7845K/B   |     |     | ±3   |               |
|                                     |                 |   | MX7845J/A/T |     |     | ±4   |               |
|                                     |                 |   | MX7845S     |     |     | ±5   |               |
| Offset Temperature Coefficient      | ΔVOS/<br>ΔTemp  |   |             |     |     | ±5   | μV/°C         |
| Gain Error                          |                 | RFB, V <sub>OUT</sub> connected                             | MX7845K/B/T |     |     | ±3   | LSB           |
|                                     |                 |   | MX7845J/A/S |     |     | ±6   |               |
|                                     |                 | RC or RB, V <sub>OUT</sub> connected; V <sub>REF</sub> = 5V | MX7845K/B/T |     |     | ±6   |               |
|                                     |                 |   | MX7845J/A/S |     |     | ±9   |               |
|                                     |                 |   | MX7845K/B/T |     |     | ±8   |               |
| MX7845J/A/S                         |                 |   | ±10         |     |     |      |               |
| Gain Temperature Coefficient        | ΔGain/<br>ΔTemp | RFB, V <sub>OUT</sub> connected                             |             |     |     | ±2   | ppm of FSR/°C |
| Reference Input Resistance          |                 |   |             | 8   | 12  | 16   | kΩ            |
| Application Resistor Ratio Matching |                 | RA to RB to RC matching                                     |             |     |     | 0.5  | %             |

# Complete, 12-Bit Multiplying DAC

MX7845

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{DD} = +15V \pm 5\%$ ,  $V_{SS} = -15V \pm 5\%$ ,  $V_{REF} = +10V$ ,  $AGND = DGND = 0V$ ,  $V_{OUT}$  connected to RFB,  $R_L = 2k\Omega$ ,  $C_L = 100pF$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , all grades, unless otherwise noted.)

| PARAMETER                 | SYMBOL   | CONDITIONS                      | MIN    | TYP | MAX       | UNITS   |
|---------------------------|----------|---------------------------------|--------|-----|-----------|---------|
| <b>DIGITAL INPUTS</b>     |          |                                 |        |     |           |         |
| Input Current             | $I_{IN}$ | $V_{IN} = 0V$ and $V_{DD}$      |        |     | $\pm 1$   | $\mu A$ |
| Input Low Voltage         | $V_{IL}$ |                                 |        |     | 0.8       | V       |
| Input High Voltage        | $V_{IH}$ |                                 | 2.4    |     |           | V       |
| Input Capacitance         | $C_{IN}$ |                                 |        | 5   |           | pF      |
| <b>POWER REQUIREMENTS</b> |          |                                 |        |     |           |         |
| Supply Voltage (Note 4)   | $V_{DD}$ |                                 | 14.25  |     | 15.75     | V       |
|                           | $V_{SS}$ |                                 | -14.25 |     | -15.75    |         |
| Supply Current            | $I_{DD}$ | $V_{OUT}$ unloaded              |        |     | 10        | mA      |
|                           | $I_{SS}$ | $V_{OUT}$ unloaded              |        |     | 4         |         |
| Power-Supply Rejection    | PSR      | $V_{DD}$ only, $V_{REF} = -10V$ |        |     | $\pm 0.2$ | %/%     |
|                           |          | $V_{SS}$ only                   |        |     | $\pm 0.2$ |         |

**Note 2:** Guaranteed monotonic over temperature.

**Note 3:** DAC register loaded with all 0s.

**Note 4:** The MX7845 can operate from  $\pm 12V$  supplies.

## TIMING CHARACTERISTICS

( $V_{DD} = +15V \pm 5\%$ ,  $V_{SS} = -15V \pm 5\%$ ,  $V_{REF} = +10V$ ,  $AGND = DGND = 0V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , all grades, unless otherwise noted.) (Note 5)

| PARAMETER                       | SYMBOL   | CONDITIONS          | MIN | TYP | MAX | UNITS |
|---------------------------------|----------|---------------------|-----|-----|-----|-------|
| Chip Select to Write-Setup Time | $t_{CS}$ | $T_A = +25^\circ C$ | 100 |     |     | ns    |
|                                 |          | MX7845J/K/A/B       | 135 |     |     |       |
|                                 |          | MX7845S/T           | 140 |     |     |       |
| Chip Select to Write-Hold Time  | $t_{CH}$ | $T_A = +25^\circ C$ | 0   |     |     | ns    |
|                                 |          | MX7845J/K/A/B       | 0   |     |     |       |
|                                 |          | MX7845S/T           | 0   |     |     |       |
| Write Pulse Width               | $t_{WR}$ | $T_A = +25^\circ C$ | 100 |     |     | ns    |
|                                 |          | MX7845J/K/A/B       | 135 |     |     |       |
|                                 |          | MX7845S/T           | 140 |     |     |       |
| Data-Setup Time                 | $t_{DS}$ | $T_A = +25^\circ C$ | 100 |     |     | ns    |
|                                 |          | MX7845J/K/A/B       | 100 |     |     |       |
|                                 |          | MX7845S/T           | 120 |     |     |       |
| Data-Hold Time                  | $t_{DH}$ | $T_A = +25^\circ C$ | 20  |     |     | ns    |
|                                 |          |                     | 20  |     |     |       |

**Note 5:** All input signal rise and fall times measured from 10% to 90% of +5V;  $t_r = t_f = 20ns$ . Timing measurement reference is  $(V_{IH} + V_{IL})/2$ .

# Complete, 12-Bit Multiplying DAC

## AC PERFORMANCE CHARACTERISTICS

( $T_A = T_{MIN}$  to  $T_{MAX}$ , all grades, unless otherwise noted.) (Note 6)

| PARAMETER                                   | SYMBOL   | CONDITIONS                                      | MIN           | TYP | MAX | UNITS                  |
|---|----------|---|---------------|-----|-----|------------------------|
| <b>DYNAMIC PERFORMANCE</b>                  |          |   |               |     |     |                        |
| Output-Voltage Settling Time (Note 7)       | $t_s$    | $V_{OUT}$ LOAD = 2k $\Omega$ , 100pF            |               | 2.5 | 5.0 | $\mu$ s                |
| Slew Rate                                   | SR       | $V_{OUT}$ LOAD = 2k $\Omega$ , 100pF            |               | 7   |     | V/ $\mu$ s             |
| DAC Glitch Impulse (Note 8)                 |          |   |               | 450 |     | (nV)(s)                |
| Multiplying Feedthrough Error (Note 9)      |          |   |               | 5   |     | mV <sub>p-p</sub>      |
| Unity-Gain Small-Signal Bandwidth (Note 10) |          | $V_{OUT}$ , RFB connected                       |               | 600 |     | kHz                    |
| Full-Power Bandwidth (Note 11)              |          | $V_{OUT}$ , RFB connected, $R_L = 2k\Omega$     |               | 250 |     | kHz                    |
| Total Harmonic Distortion (Note 12)         | THD      |   |               | -90 |     | dB                     |
| <b>OUTPUT CHARACTERISTICS (Note 13)</b>     |          |   |               |     |     |                        |
| Open-Loop Gain                              | $A_{VO}$ | $V_{OUT} = \pm 10V$ , $R_L = 2k\Omega$          | 85            |     |     | dB                     |
| Output Voltage Swing                        | $V_O$    | $R_L = 2k\Omega$ , $C_L = 100pF$                | $\pm 10$      |     |     | V                      |
| Output Resistance                           | $R_O$    | RFB, $V_{OUT}$ connected                        |               | 0.2 |     | $\Omega$               |
| Short-Circuit Current                       |          | $V_{OUT}$ , AGND connected; $T_A = +25^\circ C$ |               | 15  |     | mA                     |
| Output Noise Voltage (Note 14)              |          | $T_A = +25^\circ C$                             | 0.1Hz to 10Hz | 2   |     | $\mu$ V <sub>RMS</sub> |
|   |          |   | f = 10Hz      | 250 |     | nV $\sqrt{Hz}$         |
|   |          |   | f = 100Hz     | 100 |     |                        |
|   |          |   | f = 1kHz      | 50  |     |                        |
|   |          |   | f = 10kHz     | 50  |     |                        |
|   |          |   | f = 100kHz    | 50  |     |                        |

**Note 6:** AC PERFORMANCE CHARACTERISTICS are included for design guidance and are not subject to test.

**Note 7:** Settling to 0.01% of full-scale range. DAC register alternately loaded with all 0s and all 1s.

**Note 8:** Measured with  $V_{REF} = 0V$ . DAC register alternately loaded with all 1s and all 0s.

**Note 9:**  $V_{REF} = \pm 10V$ , 10kHz sine wave. DAC register loaded with all 0s.

**Note 10:** DAC register loaded with all 1s.  $V_{REF} = 100mV_{p-p}$  sine wave.

**Note 11:** DAC register loaded with all 1s.  $V_{REF} = 20V_{p-p}$  sine wave.

**Note 12:**  $V_{REF} = 6V_{RMS}$ , 1kHz sine wave.

**Note 13:** 2k $\Omega$  minimum specified load resistance.

**Note 14:** Includes output amplifier noise and Johnson Noise of RFB.

## Pin Description

| DIP/SO | PLCC/LCC  | NAME            | FUNCTION                       |
|--------|-----------|-----------------|--------------------------------|
| PIN    | PIN       |                 |                                |
| 1      | 2         | $V_{OUT}$       | Voltage Output                 |
| 2-11   | 3-7, 9-13 | D11-D2          | Data Bits 2 to 11 (MSB)        |
| 12     | 14        | DGND            | Digital Ground                 |
| 13, 14 | 16, 17    | D1, D0          | Data Bits 0 to 1 (LSB)         |
| 15     | 18        | $\overline{WR}$ | Write Input. Active Low.       |
| 16     | 19        | $\overline{CS}$ | Chip-Select Input. Active Low. |
| 17     | 20        | $V_{REF}$       | Reference Input to DAC         |
| 18     | 21        | AGND            | Analog Ground                  |

| DIP/SO | PLCC/LCC     | NAME     | FUNCTION                          |
|--------|--------------|----------|-----------------------------------|
| PIN    | PIN          |          |                                   |
| 19     | 23           | $V_{SS}$ | -12V to -15V Supply Voltage Input |
| 20     | 24           | $V_{DD}$ | +12V to +15V Supply Voltage Input |
| 21     | 25           | RA       | Scaling Resistor: RA = 4RFB       |
| 22     | 26           | RB       | Scaling Resistor: RB = 2RFB       |
| 23     | 27           | RC       | Scaling Resistor: RC = 2RFB       |
| 24     | 28           | RFB      | Feedback Resistor                 |
|        | 1, 8, 15, 22 | N.C.     | No Connect                        |

For application information, refer to the MAX501/MAX502 data sheet.

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