



## FEATURES

- Full Four-Quadrant Multiplying DAC
- Guaranteed Monotonic over Temperature
- Non-Linearity:  $\pm 1/2$  LSB Achieved without Trimming
- Ultra Stable: 0.2 ppm/ $^{\circ}$ C Max Linearity Tempco
- 2 ppm/ $^{\circ}$ C Max Gain Error Tempco
- Low Output Capacitance
- Low Sensitivity to Amplifier Offset 330  $\mu$ V/mV
- Low Glitch Energy
- Low Feedthrough Error
- TTL/CMOS Compatible

- Latch-Up Free
- Improved Replacement for AD7533, AD7520
- Low Cost
- CDIP, PDIP, PLCC & SOIC Packages Available

## APPLICATIONS

- Digitally Controlled Attenuators
- Programmable Gain Amplifiers
- Function Generation
- Linear Automatic Gain Control

4

## GENERAL DESCRIPTION

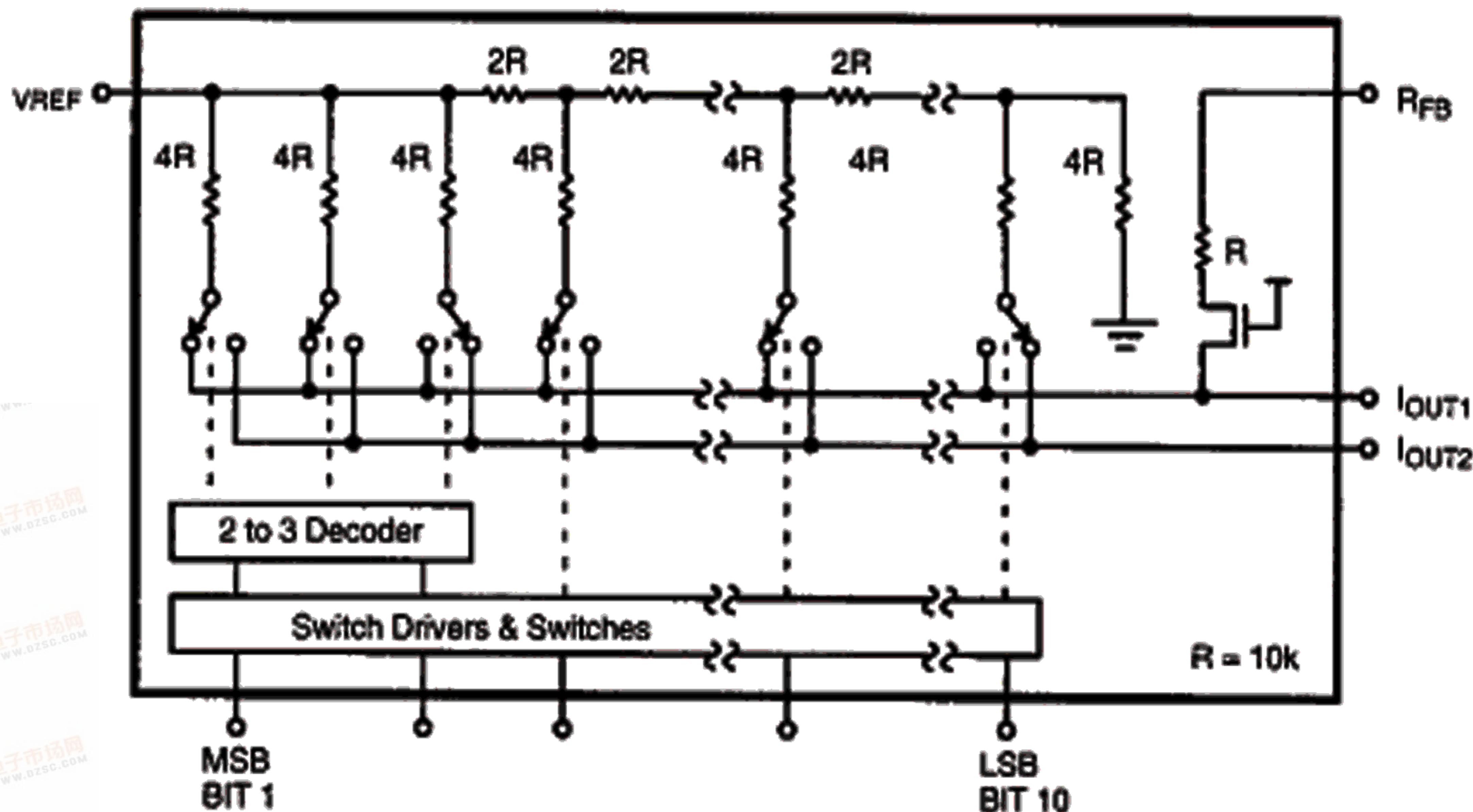
The MP7633 is pin and functionally equivalent to industry's standard AD7533, AD7520 and AD7530. The MP7633 is recommended when lower output capacitance is required. The MP7633 incorporates a unique decoding technique yielding excellent accuracy and stability (0.2 ppm/ $^{\circ}$ C linearity drift and 2 ppm/ $^{\circ}$ C scale factor drift) over temperature and time.

The 2-3 bit decoding architecture of the MP7633 results in

low output capacitances of 52/26pF at  $I_{OUT1}$  and 13/45pF at  $I_{OUT2}$ , low sensitivity to output amplifier offset of 330  $\mu$ V per millivolt offset, eliminating the need for trim pots in many applications.

Specified for operation over the commercial / industrial ( $-40$  to  $+85^{\circ}$ C) and military ( $-55$  to  $+125^{\circ}$ C) temperature ranges, the MP7633 is available in Plastic (PDIP) and Ceramic (CDIP) dual-in-line, Plastic leaded chip carrier (PLCC) and Surface Mount (SOIC) packages.

## SIMPLIFIED BLOCK DIAGRAM

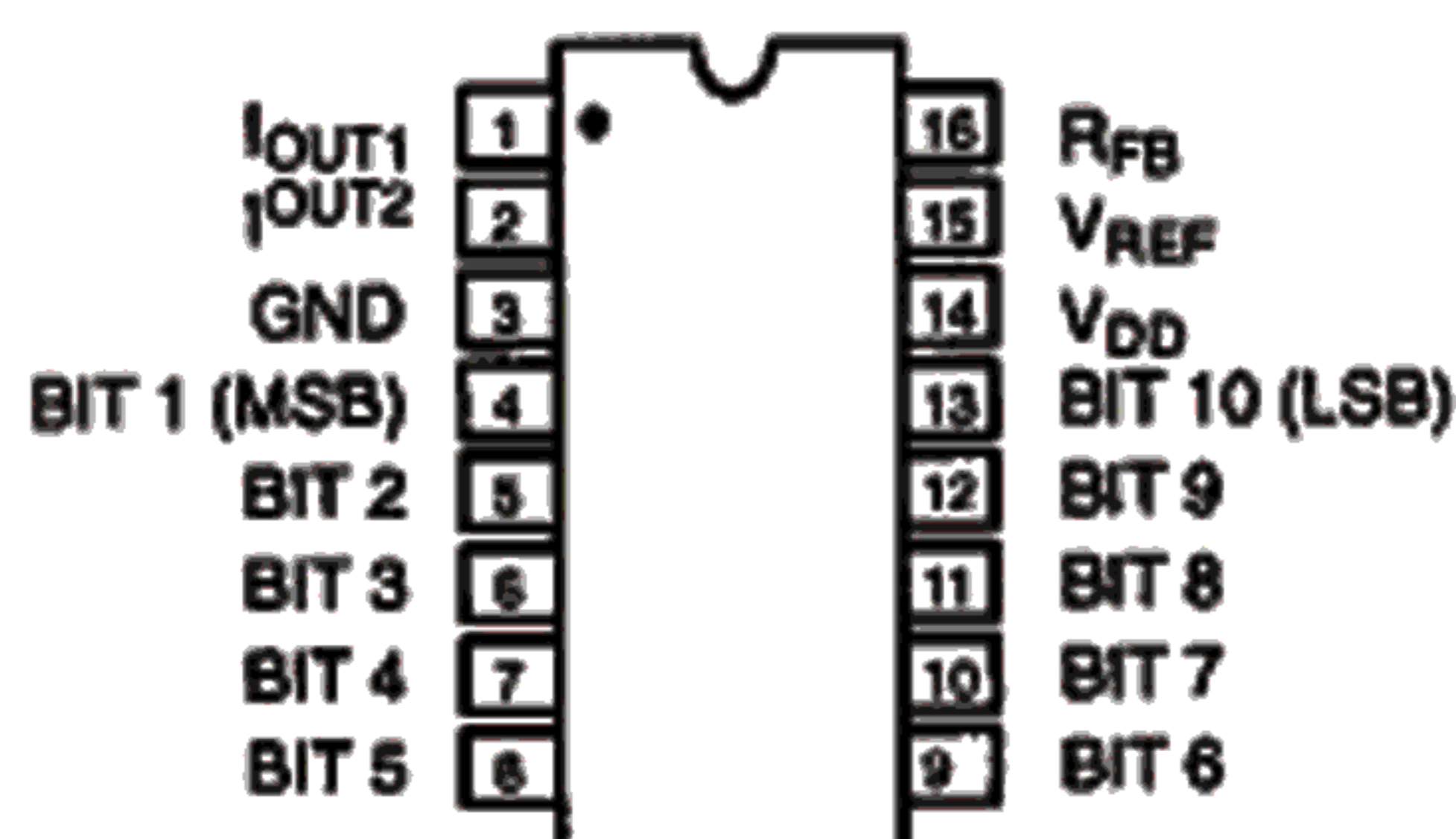


**3 Segment D/A Converter with Termination to GND.  
Logical "1" at Digital Input Steers Current to  $I_{OUT1}$**

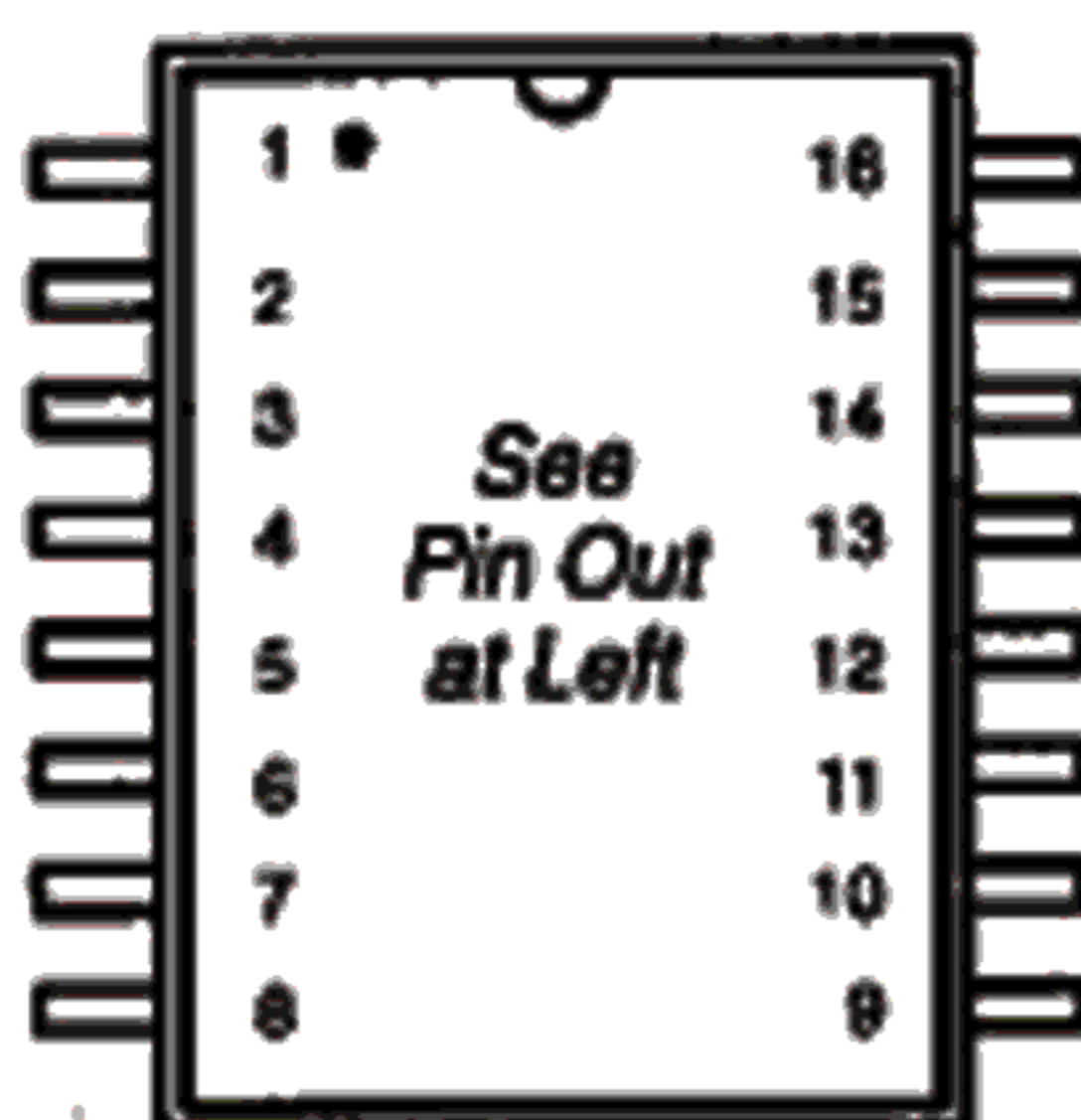
## ORDERING INFORMATION

| Package Type | Temperature Range | Part No.     | INL (LSB) | DNL (LSB) | Gain Error (% FSR) |
|--------------|-------------------|--------------|-----------|-----------|--------------------|
| Plastic Dip  | -40 to +85°C      | MP7633JN     | ±2        | ±2        | ±0.4               |
| Plastic Dip  | -40 to +85°C      | MP7633KN     | ±1        | ±1        | ±0.4               |
| Plastic Dip  | -40 to +85°C      | MP7633LN     | ±1/2      | ±1/2      | ±0.4               |
| SOIC         | -40 to +85°C      | MP7633JS     | ±2        | ±2        | ±0.4               |
| SOIC         | -40 to +85°C      | MP7633KS     | ±1        | ±1        | ±0.4               |
| SOIC         | -40 to +85°C      | MP7633LS     | ±1/2      | ±1/2      | ±0.4               |
| PLCC         | -40 to +85°C      | MP7633JP     | ±2        | ±2        | ±0.4               |
| PLCC         | -40 to +85°C      | MP7633KP     | ±1        | ±1        | ±0.4               |
| PLCC         | -40 to +85°C      | MP7633LP     | ±1/2      | ±1/2      | ±0.4               |
| Ceramic Dip  | -40 to +85°C      | MP7633AD     | ±2        | ±2        | ±0.4               |
| Ceramic Dip  | -40 to +85°C      | MP7633BD     | ±1        | ±1        | ±0.4               |
| Ceramic Dip  | -40 to +85°C      | MP7633CD     | ±1/2      | ±1/2      | ±0.4               |
| Ceramic Dip  | -55 to +125°C     | MP7633SD     | ±2        | ±2        | ±0.4               |
| Ceramic Dip  | -55 to +125°C     | MP7633SD/883 | ±2        | ±2        | ±0.4               |
| Ceramic Dip  | -55 to +125°C     | MP7633TD     | ±1        | ±1        | ±0.4               |
| Ceramic Dip  | -55 to +125°C     | MP7633TD/883 | ±1        | ±1        | ±0.4               |
| Ceramic Dip  | -55 to +125°C     | MP7633UD     | ±1/2      | ±1/2      | ±0.4               |
| Ceramic Dip  | -55 to +125°C     | MP7633UD/883 | ±1/2      | ±1/2      | ±0.4               |

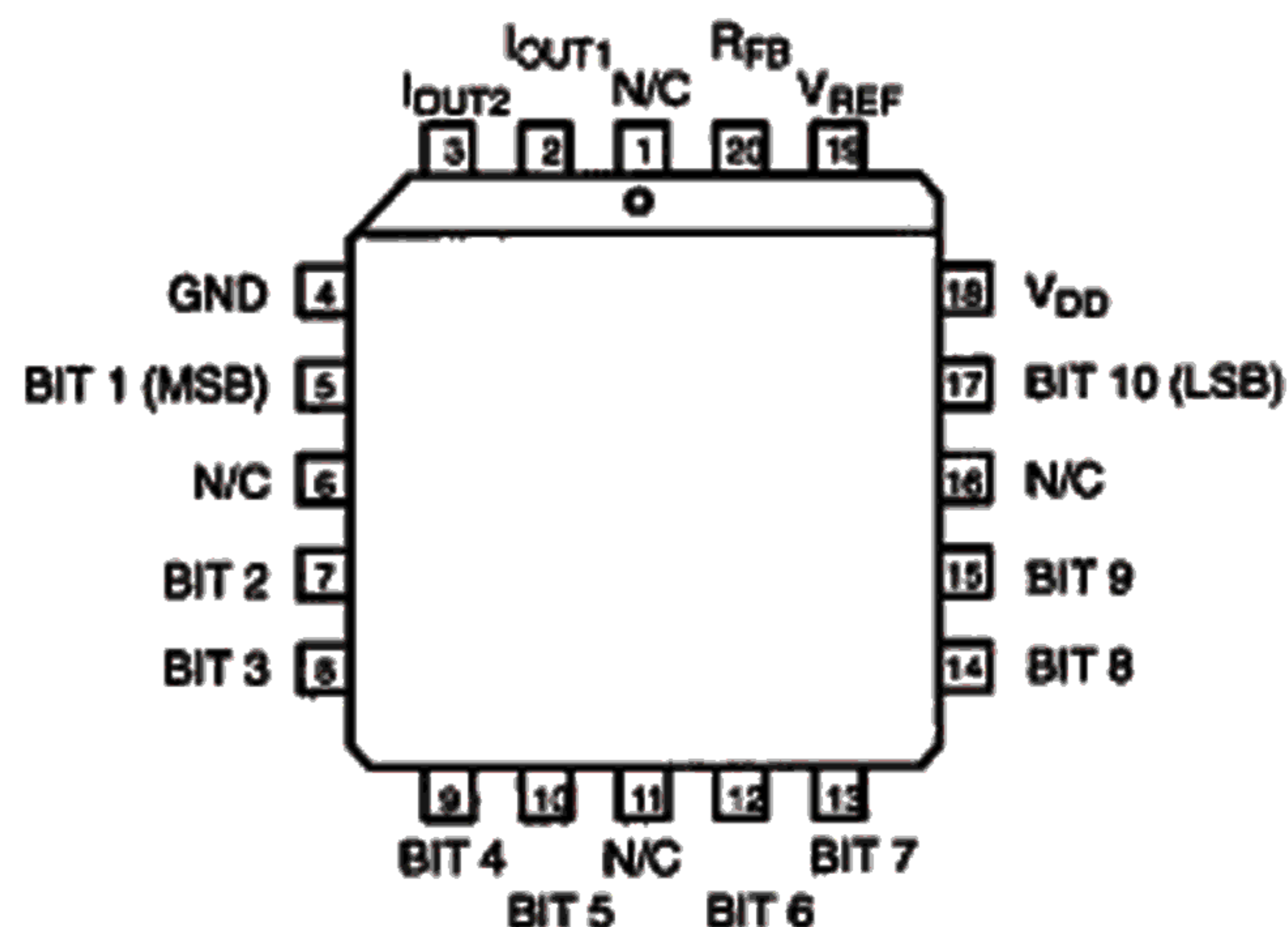
## PIN CONFIGURATIONS



16 Pin CDIP, PDIP (0.300")  
D16, N16



16 Pin SOIC (Jedec, 0.300")  
S16



20 Pin PLCC  
P20



## PIN OUT DEFINITIONS

## 16 Pin CDIP, PDIP, SOIC

| PIN NO. | NAME              | DESCRIPTION                |
|---------|-------------------|----------------------------|
| 1       | I <sub>OUT1</sub> | Current Output 1           |
| 2       | I <sub>OUT2</sub> | Current Output 2           |
| 3       | GND               | Ground                     |
| 4       | BIT 1             | Data Input Bit 1 (MSB)     |
| 5       | BIT 2             | Data Input Bit 2           |
| 6       | BIT 3             | Data Input Bit 3           |
| 7       | BIT 4             | Data Input Bit 4           |
| 8       | BIT 5             | Data Input Bit 5           |
| 9       | BIT 6             | Data Input Bit 6           |
| 10      | BIT 7             | Data Input Bit 7           |
| 11      | BIT 8             | Data Input Bit 8           |
| 12      | BIT 9             | Data Input Bit 9           |
| 13      | BIT 10            | Data Input Bit 10 (LSB)    |
| 14      | V <sub>DD</sub>   | Positive Power Supply      |
| 15      | V <sub>REF</sub>  | Reference Input Voltage    |
| 16      | R <sub>FB</sub>   | Internal Feedback Resistor |

## 20 Pin PLCC

| PIN NO. | NAME              | DESCRIPTION                |
|---------|-------------------|----------------------------|
| 1       | N/C               | No Connection              |
| 2       | I <sub>OUT1</sub> | Current Output 1           |
| 3       | I <sub>OUT2</sub> | Current Output 2           |
| 4       | GND               | Ground                     |
| 5       | BIT 1             | Data Input Bit 1 (MSB)     |
| 6       | N/C               | No Connection              |
| 7       | BIT 2             | Data Input Bit 2           |
| 8       | BIT 3             | Data Input Bit 3           |
| 9       | BIT 4             | Data Input Bit 4           |
| 10      | BIT 5             | Data Input Bit 5           |
| 11      | N/C               | No Connection              |
| 12      | BIT 6             | Data Input Bit 6           |
| 13      | BIT 7             | Data Input Bit 7           |
| 14      | BIT 8             | Data Input Bit 8           |
| 15      | BIT 9             | Data Input Bit 9           |
| 16      | N/C               | No Connection              |
| 17      | BIT 10            | Data Input Bit 10 (LSB)    |
| 18      | V <sub>DD</sub>   | Positive Power Supply      |
| 19      | V <sub>REF</sub>  | Reference Input Voltage    |
| 20      | R <sub>FB</sub>   | Internal Feedback Resistor |

## ELECTRICAL CHARACTERISTICS

( $V_{DD} = +15\text{ V}$ ,  $V_{REF} = +10\text{ V}$  unless otherwise noted)

| Parameter                                  | Symbol            | 25°C |      |      | T <sub>min</sub> to T <sub>max</sub> |      | Units               | Test Conditions/Comments   |
|--|-------------------|------|------|------|--------------------------------------|------|---------------------|--|
|  |                   | Min  | Typ  | Max  | Min                                  | Max  |                     |  |
| <b>STATIC PERFORMANCE (1)</b>              |                   |      |      |      |                                      |      |                     |  |
| Resolution (All Grades)                    | N                 | 10   |      |      | 10                                   |      | Bits                | FSR = Full Scale Range   |
| Integral Non-Linearity (Relative Accuracy) | INL               |      |      |      |                                      |      | LSB                 | Best Fit Straight Line Spec. (Max INL - Min INL) / 2   |
| J, A, S                                    |                   |      |      | ±2   |                                      | ±2   |                     |  |
| K, B, T                                    |                   |      |      | ±1   |                                      | ±1   |                     |  |
| L, C, U                                    |                   |      |      | ±1/2 |                                      | ±1/2 |                     |  |
| Differential Non-Linearity                 | DNL               |      |      |      |                                      |      | LSB                 |  |
| J, A, S                                    |                   |      |      | ±2   |                                      | ±2   |                     |  |
| K, B, T                                    |                   |      |      | ±1   |                                      | ±1   |                     |  |
| L, C, U                                    |                   |      |      | ±1/2 |                                      | ±1/2 |                     |  |
| Gain Error                                 | GE                |      | ±0.3 | ±0.4 |                                      | ±0.4 | % FSR               | Using Internal R <sub>FB</sub>   |
| Gain Temperature Coefficient (2)           | TC <sub>GE</sub>  |      |      |      |                                      | ±2   | ppm/°C              | ΔGain/ΔTemperature   |
| Power Supply Rejection Ratio               | PSRR              |      | ±5   | ±50  |                                      | ±50  | ppm/%               | ΔGain/ΔV <sub>DD</sub>  , ΔV <sub>DD</sub> = ±5%   |
| Output Leakage                             | I <sub>OUT</sub>  |      | <1   | ±10  |                                      | ±200 | nA                  | I <sub>OUT1</sub> V <sub>IN</sub> = 0 V<br>I <sub>OUT2</sub> V <sub>IN</sub> = V <sub>DD</sub> |
| <b>DYNAMIC PERFORMANCE (2)</b>             |                   |      |      |      |                                      |      |                     |  |
| Current Settling Time                      | t <sub>s</sub>    |      | 500  | 1000 |                                      |      | ns                  | Full Scale Change to 1/2 LSB   |
| AC Feedthrough at I <sub>OUT1</sub>        | F <sub>T</sub>    |      |      | 1    |                                      |      | mV p-p              | V <sub>REF</sub> = 10kHz, 20 Vp-p, sinewave  |
| <b>REFERENCE INPUT</b>                     |                   |      |      |      |                                      |      |                     |  |
| Input Resistance                           | R <sub>IN</sub>   | 5    | 10   | 20   | 5                                    | 20   | kΩ                  |  |
| Voltage Input Range (2)                    |                   |      | ±10  | ±25  |                                      |      | V                   |  |
| <b>DIGITAL INPUTS (3)</b>                  |                   |      |      |      |                                      |      |                     |  |
| Logical "1" Voltage                        | V <sub>IH</sub>   | +2.4 |      |      | +2.4                                 |      | V                   |  |
| Logical "0" Voltage                        | V <sub>IL</sub>   |      |      | +0.8 |                                      | +0.8 | V                   |  |
| Input Leakage Current                      | I <sub>LKG</sub>  |      |      | ±1.0 |                                      | ±1.0 | μA                  | V <sub>IN</sub> = 0 V and V <sub>DD</sub>  |
| <b>ANALOG OUTPUTS</b>                      |                   |      |      |      |                                      |      |                     |  |
| Output Capacitance (2)                     | C <sub>OUT1</sub> |      |      | 52   |                                      |      | pF                  | DAC Inputs all 1's   |
|  | C <sub>OUT1</sub> |      |      | 26   |                                      |      | pF                  | DAC Inputs all 0's   |
|  | C <sub>OUT2</sub> |      |      | 13   |                                      |      | pF                  | DAC Inputs all 1's   |
|  | C <sub>OUT2</sub> |      |      | 45   |                                      |      | pF                  | DAC Inputs all 0's   |
| Scale Factor (2)                           |                   |      | 100  |      |                                      |      | μA/V <sub>REF</sub> |  |
| <b>POWER SUPPLY (4)</b>                    |                   |      |      |      |                                      |      |                     |  |
| Functional Voltage Range (2)               | V <sub>DD</sub>   | 4.5  | 15   | 16   | 4.5                                  | 16   | V                   |  |
| Supply Current                             | I <sub>DD</sub>   |      |      | 2    |                                      | 2    | mA                  | All digital inputs = 0 V or all = 5 V, 15 V  |



ELECTRICAL CHARACTERISTICS (CONT'D)

NOTES:

- (1) Full Scale Range (FSR) is 10V for unipolar mode.
- (2) Guaranteed but not production tested.
- (3) Digital Input levels should not go below ground or exceed the positive supply voltage, otherwise damage may occur.
- (4) Specified values guarantee functionality. Refer to other parameters for accuracy.

Specifications are subject to change without notice

ABSOLUTE MAXIMUM RATINGS (1, 2) (TA = +25°C unless otherwise noted)

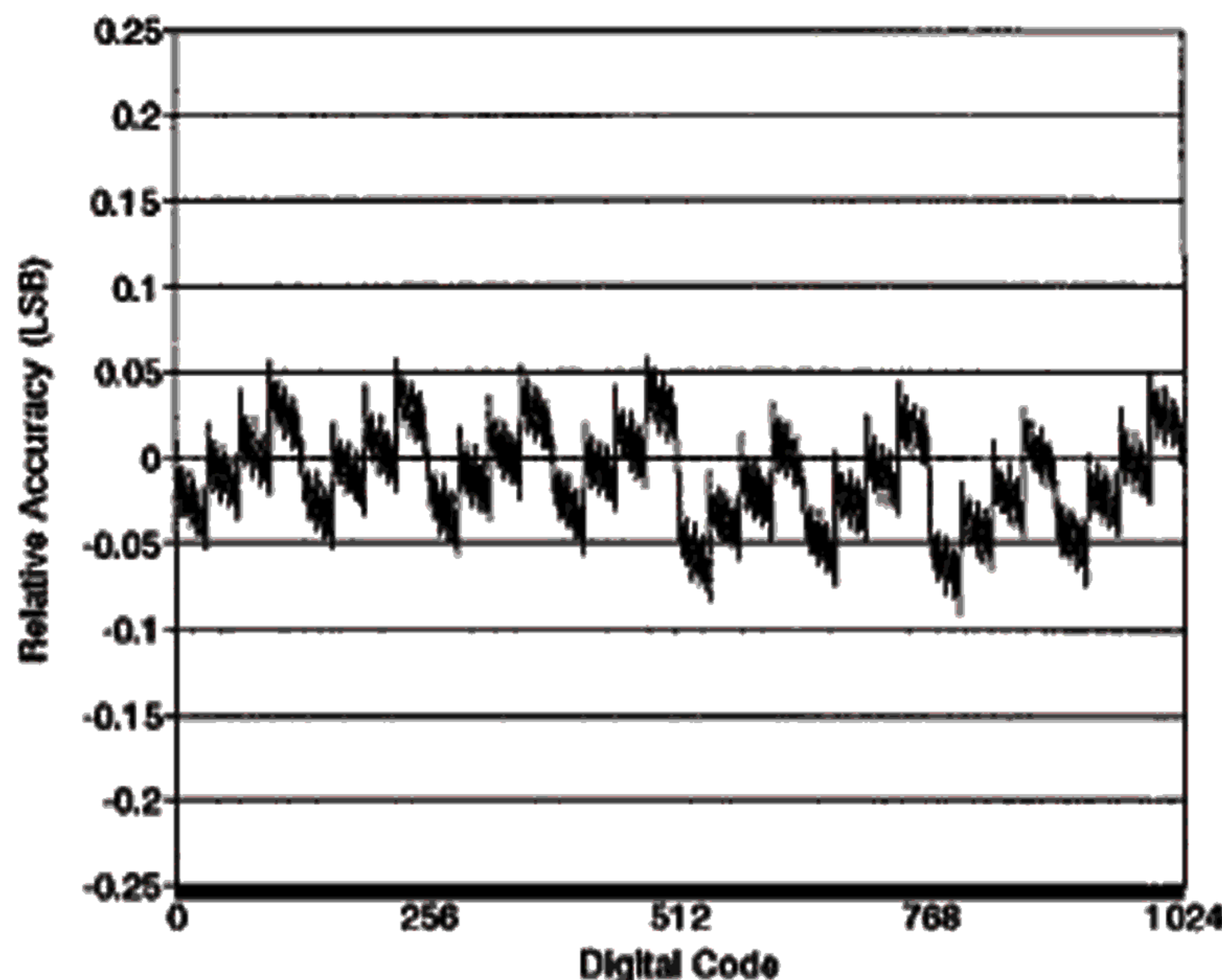
|  |  |  |                       |
|--|--|--|-----------------------|
| V <sub>DD</sub> to GND                           | ..... -0.5, +17 V                        | Storage Temperature                      | ..... -65°C to +150°C |
| Digital Input Voltage to GND (2)                 | . GND -0.5 to V <sub>DD</sub> +0.5 V     | Lead Temperature (Soldering, 10 seconds) | ..... +300°C          |
| I <sub>OUT1</sub> , I <sub>OUT2</sub> to GND (2) | ..... GND -0.5 to V <sub>DD</sub> +0.5 V | Package Power Dissipation Rating to 75°C |                       |
| V <sub>REF</sub> to GND                          | ..... ±25 V                              | CDIP, PDIP, SOIC, PLCC                   | ..... 800mW           |
| V <sub>RFB</sub> to GND                          | ..... ±25 V                              | Derates above 75°C                       | ..... 11mW/°C         |

NOTES:

- (1) Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation at or above this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.
- (2) Any input pin which can see a value outside the absolute maximum ratings should be protected by Schottky diode clamps (HP5082-2835) from input pin to the supplies. All inputs have protection diodes which will protect the device from short transients outside the supplies of less than 100mA for less than 100µs.

4

PERFORMANCE CHARACTERISTICS



Graph 1. Relative Accuracy vs. Digital Code

APPLICATION NOTES

Refer to Section 8 for Applications Information