

# ZN426E8

## 8-BIT D-A CONVERTER

The ZN426 is a monolithic 8-bit D-A converter containing an R-2R ladder network of diffused resistors with precision bipolar switches, and a 2.5V precision voltage reference.

### FEATURES

- $\pm 1/2$  LSB Linearity Error
- Guaranteed Monolithic over the Full Operating Temperature Range
- 0°C to +70°C
- TTL and 5V CMOS Compatible
- Single 5V Supply
- Settling Time 1 microsecond Typical
- Only Reference Capacitor and Resistor Required

### ABSOLUTE MAXIMUM RATINGS

- Supply voltage +7.0V
- Max.voltage, logic and  $V_{REF}$  inputs+5.5V
- Operating temperature range 0°C to +70°C
- Storage temperature range -55°C to +125°C

### ORDERING INFORMATION

- Ambient operating temperature 0°C to +70°C
- Package, ZN426E8DP14

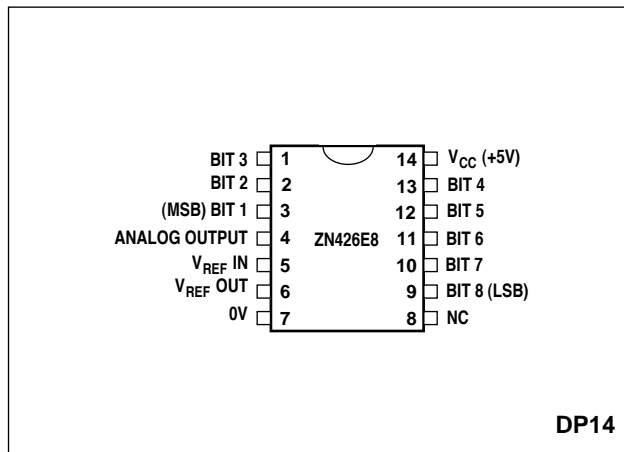


Fig.1 Pin connections (not to scale) - top view

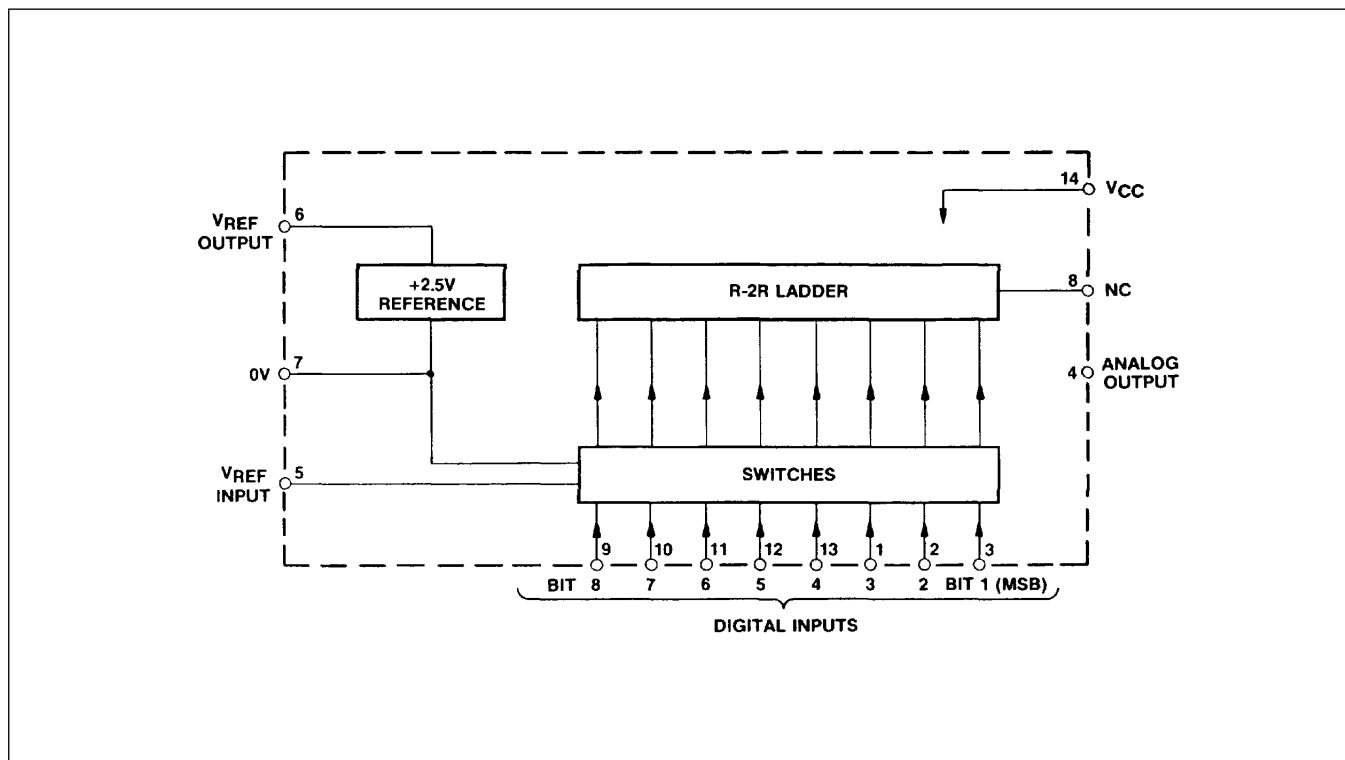


Fig.2 System diagram

## ZN426

### ELECTRICAL CHARACTERISTICS

(at  $T_{amb} = 25^{\circ}\text{C}$  and  $V_{CC} = +5\text{V}$  unless otherwise specified)

| Parameter   | Symbol    | Min.  | Typ.      | Max.      | Units                          | Conditions                                    |
|---|-----------|-------|-----------|-----------|--------------------------------|---|
| Converter Resolution                                |           | 8     | -         | -         | bits                           |   |
| Non-linearity                                       |           | -     | -         | $\pm 0.5$ | LSB                            |   |
| Differential non-linearity                          |           | -     | $\pm 0.5$ | -         | LSB                            | Note 1  |
| Settling time to 0.5LSB                             |           | -     | 1.0       | -         | $\mu\text{s}$                  | 1LSB step                                     |
| Settling time to 0.5LSB                             |           | -     | 2.0       | -         | $\mu\text{s}$                  | All bits ON to OFF or OFF to ON               |
| Offset voltage ZN426E8 and D                        | $V_{OS}$  | -     | 3.0       | 5.0       | mV                             | All bits OFF                                  |
| $V_{OS}$ temperature coefficient                    |           | -     | 5         | -         | $\mu\text{V}/^{\circ}\text{C}$ |   |
| Full-scale output                                   |           | 2.545 | 2.550     | 2.555     | V                              | All bits ON<br>Ext. $V_{REF} = 2.560\text{V}$ |
| Full-scale temp. coefficient                        |           | -     | 3         | -         | $\text{ppm}/^{\circ}\text{C}$  | Ext. $V_{REF} = 2.560\text{V}$                |
| Non-linearity temp. coefficient                     |           | -     | 7.5       | -         | $\text{ppm}/^{\circ}\text{C}$  | Relative to F.S.R.                            |
| Analog output resistance                            | $R_O$     | -     | 10        | -         | $\text{k}\Omega$               |   |
| External reference voltage                          |           | 0     | -         | 3.0       | V                              |   |
| Supply voltage                                      | $V_{CC}$  | 4.5   | -         | 5.5       | V                              |   |
| Supply current                                      | $I_S$     | -     | 5         | 9         | mA                             |   |
| High level input voltage                            | $V_{IH}$  | 2.0   | -         | -         | V                              |   |
| Low level input voltage                             | $V_{IL}$  | -     | -         | 0.7       | V                              |   |
| High level input current                            | $I_{IH}$  | -     | -         | 10        | $\mu\text{A}$                  | $V_{CC} = \text{max.}$<br>$V_I = 2.4\text{V}$ |
|   |           | -     | -         | 100       | $\mu\text{A}$                  | $V_{CC} = \text{max.}$<br>$V_I = 5.5\text{V}$ |
| Low level input current                             | $I_{IL}$  | -     | -         | -0.18     | mA                             | $V_{CC} = \text{max.}$<br>$V_I = 0.3\text{V}$ |
| <b>Internal voltage reference</b><br>Output voltage | $V_{REF}$ | 2.475 | 2.55      | 2.626     | V                              | Note 2 $R_{REF} = 390\Omega$                  |
| Slope resistance                                    | $R_S$     | -     | 1         | 2         | $\Omega$                       | $R_{REF} = 390\Omega$                         |
| $V_{REF}$ temperature coefficient                   |           | -     | 40        | -         | $\text{ppm}/^{\circ}\text{C}$  | $R_{REF} = 390\Omega$                         |

NOTE 1: Monotonic over full temperature range.

NOTE 2: The internal reference requires a  $1\mu\text{F}$  stabilising capacitor between  $V_{REF\ OUT}$  and 0V and a  $390\Omega$  resistor,  $R_{REF}$  between  $V_{CC}$  and  $V_{REF\ OUT}$ .

### INTRODUCTION

The ZN426 is an 8-bit D-A converter. It contains an advanced design of R-2R ladder network and an array of precision bipolar switches plus a 2.5V precision voltage reference on a single monolithic chip.

The special design of the ladder network results in full 8-bit accuracy using normal defused resistors.

The use of on-chip voltage reference is pin optional to retain flexibility. An external fixed or varying reference may therefore be substituted. In this case there is no need to supply power to the internal reference so  $R_{REF}$  and  $C_{REF}$  can be omitted.

The converter is of the voltage switching type and uses an R-2R resistor ladder network as shown in Fig.3.

Each 2R element is connected either to 0V or  $V_{REF}$  by transistor switches specially designed for low offset voltage (typically 1mV).

Binary weighted voltages are produced at the output of the R-2R ladder, the value depending on the digital number applied to the bit inputs.

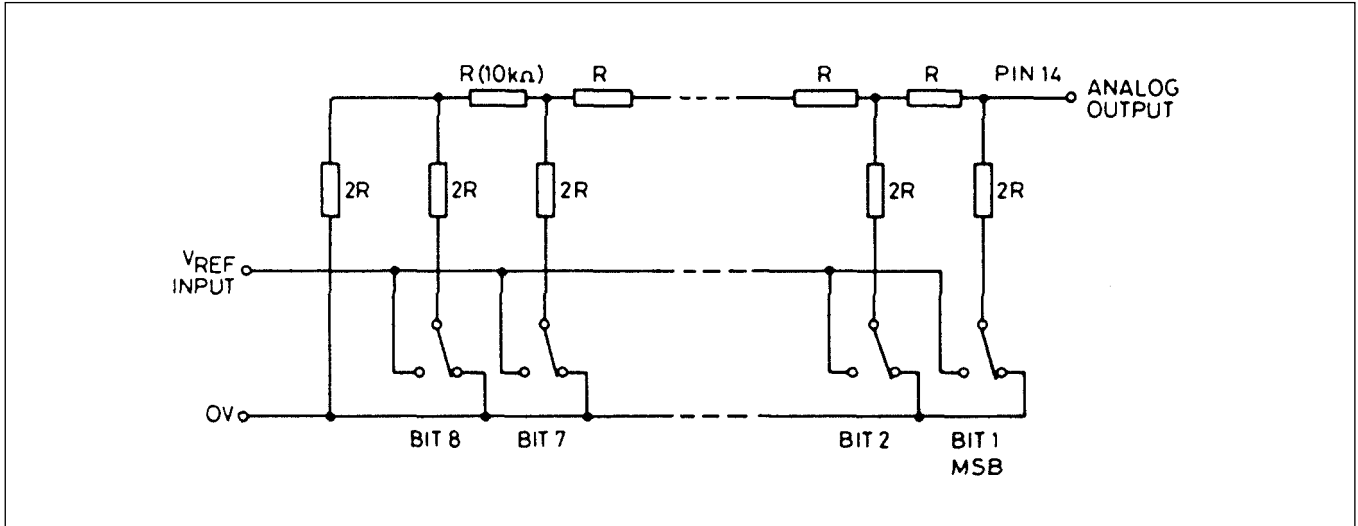


Fig.3 The R-2R ladder network

**APPLICATIONS**

**8-bit D-A Converter**

The ZN426 gives an analog voltage output directly from pin 4 therefore the usual current to voltage converting amplifier is not required. The output voltage drift, due to the temperature coefficient of the analog output resistance  $R_O$ , will be less than 0.004% per °C (or 1LSB/100°C) if  $R_L$  is chosen to be  $\geq 650k\Omega$ .

In order to remove the offset voltage and to calibrate the converter a buffer amplifier is necessary. Fig.4 shows a typical scheme using the internal reference voltage. To minimise temperature drift in this and similar applications the source resistance to the inverting input of the operational amplifier should be approximately 6kΩ. The calibration procedure is as follows:

- i. Set all bits to OFF (low) and adjust  $R_2$  until  $V_{OUT} = 0.000V$ .
- ii. Set all bits to ON (high) and adjust  $R_1$  until  $V_{OUT} = \text{Normal full-scale reading} - 1\text{LSB}$
- iii. Repeat i. and ii.  
 e.g. Set F.S.R. to  $+3.840V - 1\text{LSB} = 3.825V$   
 $(1\text{LSB} = \frac{3.84}{256} = 15.0\text{mV})$

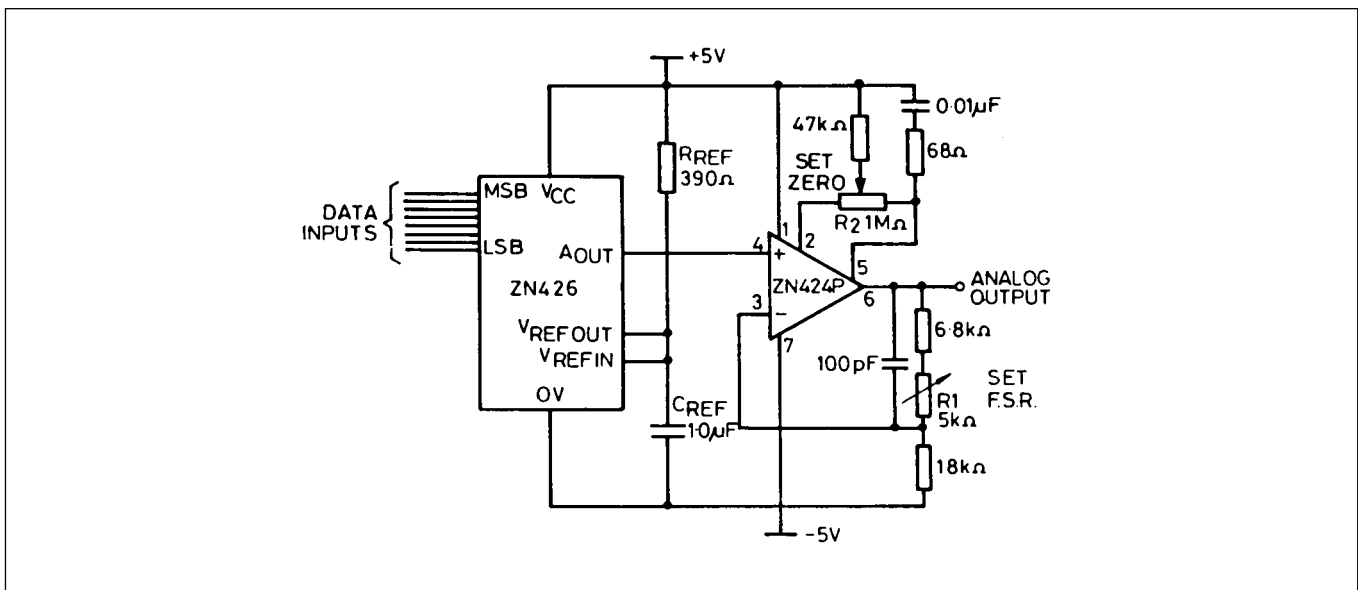


Fig.4 8-bit D-A converter

## ZN426

### Alternative Output Buffer Using the 741

The circuit of Fig.5, employing the 741 operational amplifier, may be used as the output buffer.

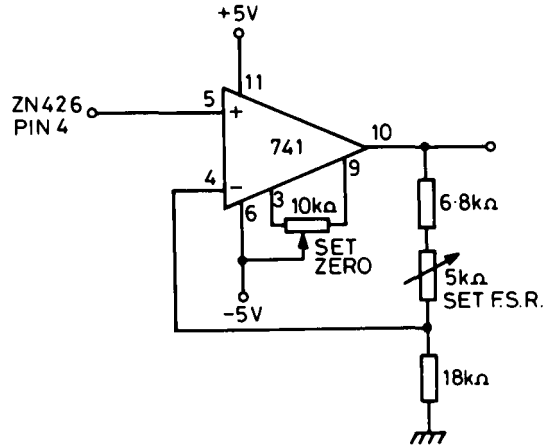


Fig.5 The ZLD741 as output buffer