FERRANTI semiconductors®

ZN429 Series

Low Cost 8 Bit Monolithic D to A Converter

FEATURES

- 8, 7 and 6-bit Accuracy
- ZN429E Series Commercial Temp. Range 0°C to +70°C
- ZN429J-8 Military Temp. Range −55°C to +125°C
- TTL and 5V CMOS Compatible
- Single +5V Supply
- Settling Time 1 μsec. Typical
- Designed for low-cost applications

DESCRIPTION

The ZN429 is a monolithic 8-bit digital to analogue converter containing an R-2R ladder network of diffused resistors with precision bipolar switches.

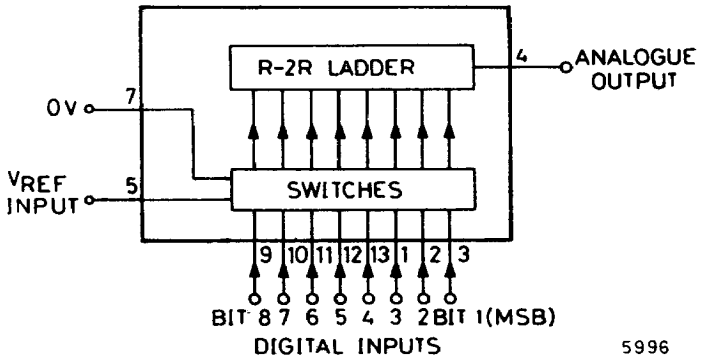


Fig. 1. System Diagram

ZN429 Series

INTRODUCTION

The ZN429 is an 8-bit digital to analogue converter. It contains an advanced design of R-2R ladder network and an array of precision bipolar switches on a single monolithic chip.

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

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

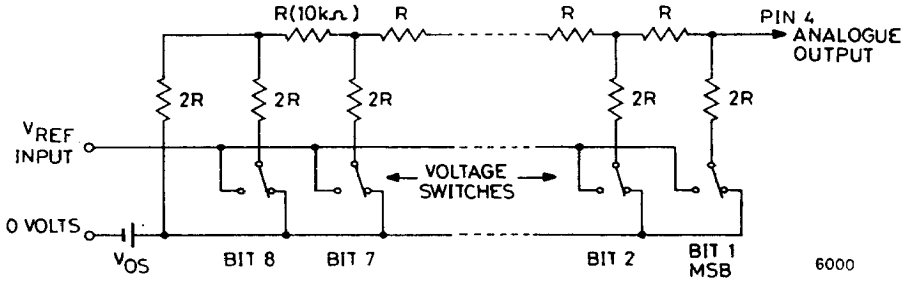


Fig. 2. The R-2R Ladder Network

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

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.

An external fixed or varying reference is required which should have a slope resistance less than 2 ohms.

Suggested external reference sources are the ZN404 or one of the ZN458 range. Each ZN404 is capable of supplying up to five ZN429 circuits and this is increased to ten for the ZN458 range.

ORDERING INFORMATION

Operating Temperature	8-bit accuracy	7-bit accuracy	6-bit accuracy	Package
0 to +70°C	ZN429E-8	ZN429E-7	ZN429E-6	Plastic
–55 to +125°C	ZN429J-8	—	—	Ceramic

ABSOLUTE MAXIMUM RATINGS

Supply voltage V_{CC}	+7.0 volts
Max. voltage, logic and V_{REF} inputs	+5.5 volts
Storage temperature range	–55 to +125°C

CHARACTERISTICS (at T_{amb} = 25°C and V_{CC} = +5 volts unless otherwise specified).

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Converter Resolution		8	—	—	bits	
Accuracy (useful resolution) ZN429J-8, ZN429E-8		8	—	—	bits	V_{REF} input = 2.0 to 3.0 volts
ZN429E-7		7	—	—	bits	
ZN429E-6		6	—	—	bits	
Non-linearity		—	—	±0.5	L.S.B.	*Note 1*
Differential non-linearity		—	±0.5	—	L.S.B.	*Note 2*
Settling time to 0.5 L.S.B.		—	1.0	—	μs	1 L.S.B. step
Settling time to 0.5 L.S.B.		—	2.0	—	μs	All bits ON to OFF or OFF to ON
Offset voltage ZN429J-8, ZN429E-8	V_{OS}	—	5.0	8.0	mV	All bits OFF *Note 1*
ZN429E-7, ZN429E-6		—	3.0	5.0	mV	
V_{OS} temperature coefficient		—	5	—	μV/°C	
Full scale output		2.545	2.550	2.555	volts	All bits ON Ext. V_{REF} = 2.560V
Full scale temp. coefficient		—	3	—	ppm/°C	Ext. V_{REF} = 2.560V
Non-linearity temp. coeff.		—	7.5	—	ppm/°C	Relative to F.S.R.

Notes:

1. The ZN429J-8 differs from the ZN429E-8 in the following respects:
   (a) For the ZN429J-8, the maximum linearity error may increase to ±0.4% FSR i.e. ±1 LSB over the temperature ranges −55°C to 0°C and +70°C to +125°C.
   (b) Offset voltage. The difference is due to package lead resistance. This offset will normally be removed by the setting up procedure, and because the offset temperature coefficient is low, the specified accuracy will be maintained.
2. Monotonic over full temperature range at resolution appropriate to accuracy.

CHARACTERISTICS (*continued*)

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Analogue output resistance	R_o	—	10	—	kΩ	
External reference voltage		0	—	3.0	volts	
Supply voltage	V_{CC}	4.5	—	5.5	volts	
Supply current	I_s	—	5	9	mA	
High level input voltage	V_{IH}	2.0	—	—	volts	
Low level input voltage	V_{IL}	—	—	0.7	volts	
High level input current	I_{IH}	—	—	10	μA	V_{CC} = max., V_I = 2.4V
		—	—	100	μA	V_{CC} = max., V_I = 5.5V
Low level input current	I_{IL}	—	—	–0.18	mA	V_{CC} = max., V_I = 0.3V

APPLICATIONS

1. 8-bit D to A Converter

The ZN429 gives an analogue 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 Analogue Output Resistance R_o, will be less than 0.004% per °C (or 1 L.S.B./100°C) if R_L is chosen to be $\geqslant$650 kΩ

In order to remove the offset voltage and to calibrate the converter a buffer amplifier is necessary. Fig. 3 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 6 kΩ. 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} = Nominal full scale reading –1 L.S.B.

iii. Repeat *i.* and *ii.*

e.g. Set F.S.R. to +3.840 volts – 1 L.S.B.
= 3.825 volts

$$(1 \text{ L.S.B.} = \frac{3.84}{256} = 15.0 \text{ millivolts})$$

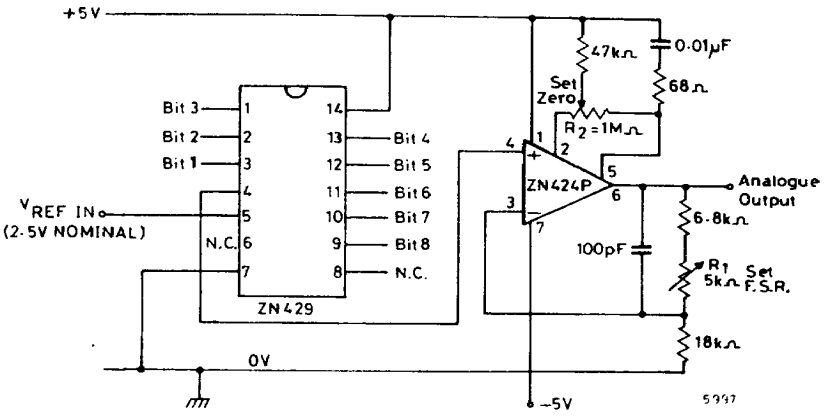


Fig. 3. 8-bit Digital to Analogue Converter

Alternative Output Buffer using the ZLD741

The following circuit, employing the ZLD741 operational amplifier, may be used as the output buffer (Fig. 3).

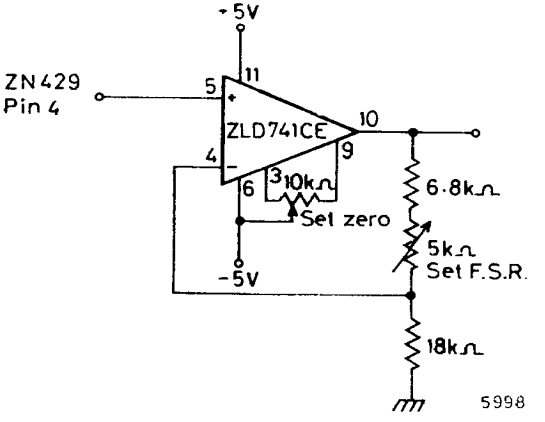
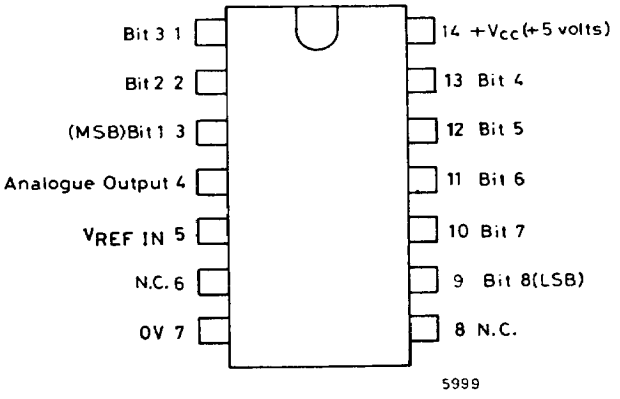


Fig. 4. The ZLD741 as Output Buffer

PIN CONNECTIONS



CHIP DIMENSIONS AND LAYOUT