



# CMOS 4/8 Channel Analog Multiplexers

## AD7501/AD7502/AD7503

### FEATURES

DTL/TTL/CMOS Direct Interface

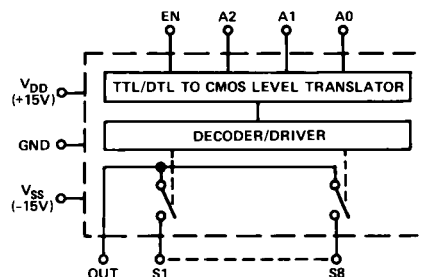
Power Dissipation: 30 $\mu$ W

R<sub>ON</sub>: 170 $\Omega$

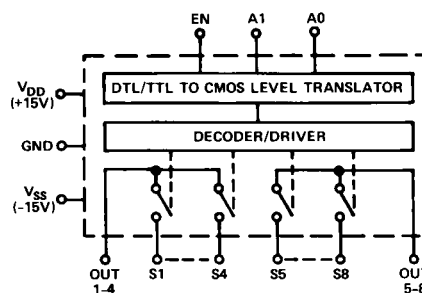
Standard 16-Pin DIPs and 20-Terminal Surface Mount Packages

### FUNCTIONAL BLOCK DIAGRAMS

AD7501/AD7503



AD7502



### GENERAL DESCRIPTION

The AD7501 and AD7503 are monolithic CMOS, 8-channel analog multiplexers which switches one of 8 inputs to a common output depending on the state of three binary address lines and an "enable" input. The AD7503 is identical to the AD7501 except its "enable" logic is inverted. All digital inputs are TTL/DTL and CMOS logic compatible.

The AD7502 is a monolithic CMOS dual 4-channel analog multiplexer. Depending on the state of 2 binary address inputs and an "enable", it switches two output buses to two of 8 inputs.

### TRUTH TABLES

| AD7501         |                |                |                |      |
|----------------|----------------|----------------|----------------|------|
| A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> | E <sub>N</sub> | "ON" |
| 0              | 0              | 0              | 1              | 1    |
| 0              | 0              | 1              | 1              | 2    |
| 0              | 1              | 0              | 1              | 3    |
| 0              | 1              | 1              | 1              | 4    |
| 1              | 0              | 0              | 1              | 5    |
| 1              | 0              | 1              | 1              | 6    |
| 1              | 1              | 0              | 1              | 7    |
| 1              | 1              | 1              | 1              | 8    |
| X              | X              | X              | 0              | None |

| AD7503         |                |                |                |      |
|----------------|----------------|----------------|----------------|------|
| A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> | E <sub>N</sub> | "ON" |
| 0              | 0              | 0              | 0              | 1    |
| 0              | 0              | 1              | 0              | 2    |
| 0              | 1              | 0              | 0              | 3    |
| 0              | 1              | 1              | 0              | 4    |
| 1              | 0              | 0              | 0              | 5    |
| 1              | 0              | 1              | 0              | 6    |
| 1              | 1              | 0              | 0              | 7    |
| 1              | 1              | 1              | 0              | 8    |
| X              | X              | X              | 1              | None |

| AD7502         |                |                |       |
|----------------|----------------|----------------|-------|
| A <sub>1</sub> | A <sub>0</sub> | E <sub>N</sub> | "ON"  |
| 0              | 0              | 1              | 1 & 5 |
| 0              | 1              | 1              | 2 & 6 |
| 1              | 0              | 1              | 3 & 7 |
| 1              | 1              | 1              | 4 & 8 |
| X              | X              | 0              | None  |

### REV. A

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# AD7501/AD7502/AD7503—SPECIFICATIONS ( $V_{DD} = +15V$ , $V_{SS} = -15V$ unless otherwise noted.)

| PARAMETER                                           | VERSION <sup>1</sup> | SWITCH<br>CONDITION | @25°C                           |                               | OVER SPECIFIED<br>TEMP. RANGE |                        | TEST CONDITIONS                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------|----------------------|---------------------|---------------------------------|-------------------------------|-------------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                     |                      |                     | AD7501, AD7503                  | AD7502                        | AD7501,<br>AD7503             | AD7502                 |                                                                                                                                                                                                                                                                                    |
| ANALOG SWITCH                                       |                      |                     |                                 |                               |                               |                        |                                                                                                                                                                                                                                                                                    |
| R <sub>ON</sub>                                     | All                  | ON                  | 170Ω typ, 300Ω max              | *                             |                               |                        | -10V ≤ V <sub>S</sub> ≤ +10V<br>I <sub>S</sub> = 1.0mA<br>V <sub>S</sub> = 0V, I <sub>S</sub> = 1.0mA                                                                                                                                                                              |
| R <sub>ON</sub> vs. V <sub>S</sub>                  | All                  | ON                  | 20% typ                         | *                             |                               |                        |                                                                                                                                                                                                                                                                                    |
| R <sub>ON</sub> vs. Temperature                     | All                  | ON                  | 0.5%/°C typ                     | *                             |                               |                        |                                                                                                                                                                                                                                                                                    |
| ΔR <sub>ON</sub> Between Switches                   | All                  | ON                  | 4% typ                          | *                             |                               |                        |                                                                                                                                                                                                                                                                                    |
| R <sub>ON</sub> vs. Temperature Between<br>Switches | All                  | ON                  | ±0.01%/°C                       | *                             |                               |                        | V <sub>S</sub> = -10V, V <sub>OUT</sub> = +10V and<br>V <sub>S</sub> = +10V, V <sub>OUT</sub> = -10V<br>V <sub>S</sub> = -10V, V <sub>OUT</sub> = +10V and<br>V <sub>S</sub> = +10V, V <sub>OUT</sub> = -10V<br>AD7501/02: Enable LOW<br>AD7503: Enable HIGH<br>V <sub>S</sub> = 0 |
| I <sub>S</sub>                                      | K<br>S               | OFF<br>OFF          | 0.2nA typ, 2nA max<br>0.5nA max | *<br>*                        | 50nA max<br>50nA max          | *<br>*                 |                                                                                                                                                                                                                                                                                    |
| I <sub>OUT</sub>                                    | K<br>S               | OFF<br>OFF          | 1nA typ, 10nA max<br>5nA max    | 0.6nA typ, 5nA max<br>3nA max | 250nA max<br>250nA max        | 125nA max<br>125nA max |                                                                                                                                                                                                                                                                                    |
| I <sub>OUT</sub> - I <sub>S</sub>                   | K<br>S               | ON<br>ON            | 12nA max<br>5.5nA max           | 7nA max<br>3.5nA max          | 300nA max<br>300nA max        | 175nA max<br>175nA max |                                                                                                                                                                                                                                                                                    |
| DIGITAL CONTROL                                     |                      |                     |                                 |                               |                               |                        |                                                                                                                                                                                                                                                                                    |
| V <sub>INL</sub>                                    | All                  |                     |                                 |                               | 0.8V max                      | *                      | V <sub>IN</sub> = 0 to +5.0V<br>(See Test Circuit 2)                                                                                                                                                                                                                               |
| V <sub>INH</sub>                                    | All                  |                     |                                 |                               | 2.4V min                      | *                      |                                                                                                                                                                                                                                                                                    |
| I <sub>INL</sub> or I <sub>INH</sub>                | All                  |                     | 10nA typ                        | *                             |                               |                        |                                                                                                                                                                                                                                                                                    |
| C <sub>IN</sub>                                     | All                  |                     | 3pF typ                         | *                             |                               |                        |                                                                                                                                                                                                                                                                                    |
| DYNAMIC CHARACTERISTICS                             |                      |                     |                                 |                               |                               |                        |                                                                                                                                                                                                                                                                                    |
| t <sub>ON</sub>                                     | All                  |                     | 0.8μs typ                       | *                             |                               |                        | V <sub>IN</sub> = 0 to +5.0V<br>(See Test Circuit 2)                                                                                                                                                                                                                               |
| t <sub>OFF</sub>                                    | All                  |                     | 0.8μs typ                       | *                             |                               |                        |                                                                                                                                                                                                                                                                                    |
| C <sub>S</sub>                                      | All                  | OFF                 | 5pF typ                         | *                             |                               |                        |                                                                                                                                                                                                                                                                                    |
| C <sub>OUT</sub>                                    | All                  | OFF                 | 30pF typ                        | 15pF typ                      |                               |                        |                                                                                                                                                                                                                                                                                    |
| C <sub>SOUT</sub>                                   | All                  | OFF                 | 0.5pF typ                       | *                             |                               |                        |                                                                                                                                                                                                                                                                                    |
| C <sub>SS</sub> Between Any Two Switches            | All                  | OFF                 | 0.5pF typ                       | *                             |                               |                        |                                                                                                                                                                                                                                                                                    |
| POWER SUPPLY                                        |                      |                     |                                 |                               |                               |                        |                                                                                                                                                                                                                                                                                    |
| I <sub>DD</sub>                                     | All                  |                     | 500μA max                       | *                             | 500μA max                     | *                      | All Digital Inputs Low                                                                                                                                                                                                                                                             |
| I <sub>SS</sub>                                     | All                  |                     | 500μA max                       | *                             | 500μA max                     | *                      |                                                                                                                                                                                                                                                                                    |
| I <sub>DD</sub>                                     | All                  |                     | 800μA max                       | *                             | 800μA max                     | *                      | All Digital Inputs High                                                                                                                                                                                                                                                            |
| I <sub>SS</sub>                                     | All                  |                     | 800μA max                       | *                             | 800μA max                     | *                      |                                                                                                                                                                                                                                                                                    |

## NOTES

\*Same specifications as AD7501 and AD7503.

<sup>1</sup>KN version specified for 0 to +70°C, KQ version for -25°C to +85°C; and SQ, SE versions for -55°C to +125°C.

Specifications subject to change without notice.

## ABSOLUTE MAXIMUM RATINGS\*

( $T_A = +25^\circ C$  unless otherwise noted)

|                                                  |                     |
|--------------------------------------------------|---------------------|
| $V_{DD}$ to GND                                  | +17V                |
| $V_{SS}$ to GND                                  | -17V                |
| V Between Any Switch Terminals (see Note 1)      | 25V                 |
| Digital Input Voltage Range                      | $V_{DD}$ to GND     |
| Overvoltage at $V_{OUT}$ ( $V_S$ )               | $V_{SS}$ , $V_{DD}$ |
| Switch Current ( $I_S$ , Continuous One Channel) | 35mA                |
| Switch Current ( $I_S$ , Surge One Channel)      |                     |
| 1ms Duration, 10% Duty Cycle                     | 50mA                |
| Power Dissipation (Any Package)                  |                     |
| Up to +75°C                                      | 450mW               |
| Derates above +75°C by                           | 6mW/°C              |

## Operating Temperature

|                                     |                 |
|-------------------------------------|-----------------|
| Commercial (KN Version)             | 0 to +70°C      |
| Industrial (KQ Version)             | -25°C to +85°C  |
| Extended (SQ, SE Versions)          | -55°C to +125°C |
| Storage Temperature                 | -65°C to +150°C |
| Lead Temperature (Soldering, 10sec) | +300°C          |

## CAUTION

- Do not apply voltages higher than  $V_{DD}$  and  $V_{SS}$  to any other terminal, especially when  $V_{SS} = V_{DD} = 0V$  all other pins should be at 0V.
- The digital control inputs are diode protected; however, permanent damage may occur on unconnected units under high energy electrostatic fields. Keep unused units in conductive foam at all times.

## CAUTION:

ESD (electrostatic discharge) sensitive device. The digital control inputs are diode protected; however, permanent damage may occur on unconnected devices subject to high energy electrostatic fields. Unused devices must be stored in conductive foam or shunts. The protective foam should be discharged to the destination socket before devices are inserted.



## ORDERING GUIDE

| Model <sup>1</sup> | Temperature Range | Package Option <sup>2</sup> |
|--------------------|-------------------|-----------------------------|
| AD7501KN           | 0°C to +70°C      | N-16                        |
| AD7501KQ           | -25°C to +85°C    | Q-16                        |
| AD7501SQ           | -55°C to +125°C   | Q-16                        |
| AD7501SE           | -55°C to +125°C   | E-20A                       |
| AD7502KN           | 0°C to +70°C      | N-16                        |
| AD7502KQ           | -25°C to +85°C    | Q-16                        |
| AD7502SQ           | -55°C to +125°C   | Q-16                        |
| AD7502SE           | -55°C to +125°C   | E-20A                       |
| AD7503KN           | 0°C to +70°C      | N-16                        |
| AD7503KQ           | -25°C to +85°C    | Q-16                        |
| AD7503SQ           | -55°C to +125°C   | Q-16                        |
| AD7503SE           | -55°C to +125°C   | E-20A                       |

## NOTES

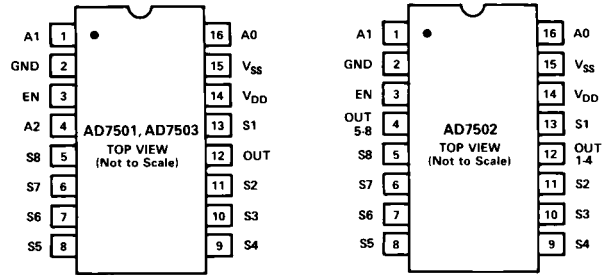
<sup>1</sup>To order MIL-STD-883, Class B processed parts, add/883B to part number.

See the Analog Devices' 1990 Military Databook for military data sheet.

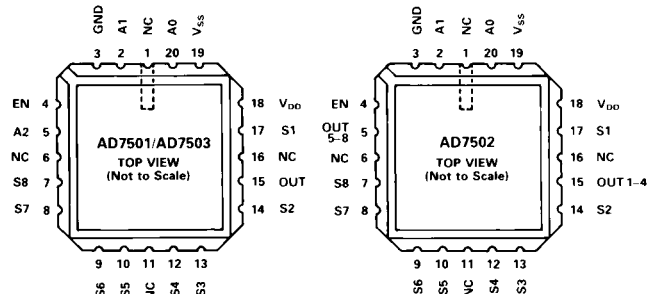
<sup>2</sup>E = Leadless Ceramic Chip Carrier; N = Narrow Plastic DIP; Q = Cerdip.

## PIN CONFIGURATIONS

### DIP



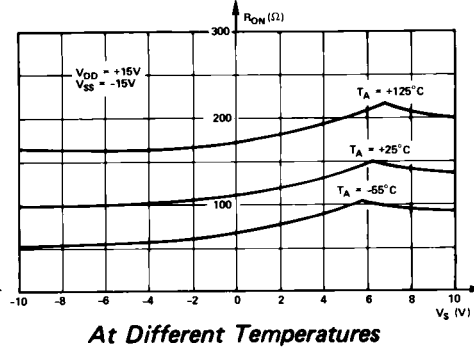
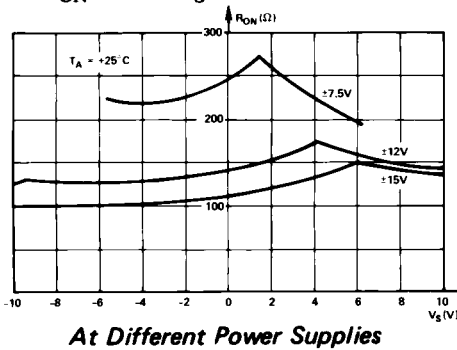
### LCCC



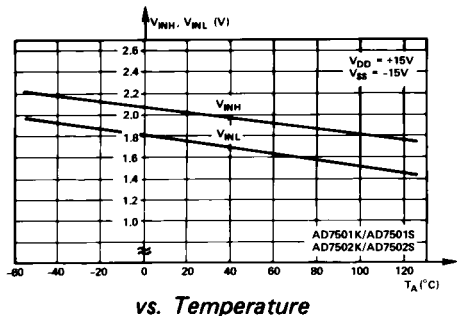
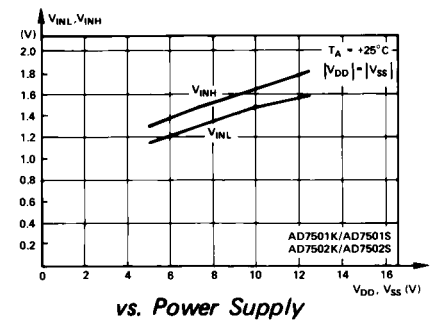
NC = NO CONNECT

## Typical Performance Characteristics

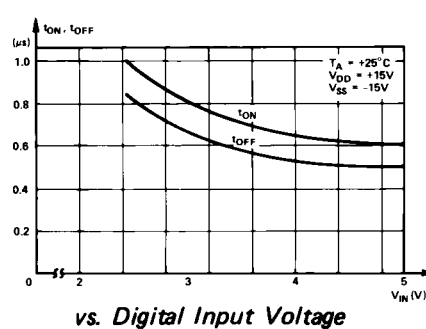
### 1. $R_{ON}$ Versus $V_S$



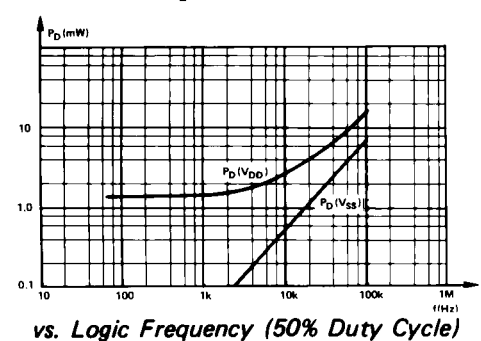
### 2. Digital Threshold Voltage ( $V_{INH}$ , $V_{INL}$ )



### 3. $t_{ON}$ , $t_{OFF}$



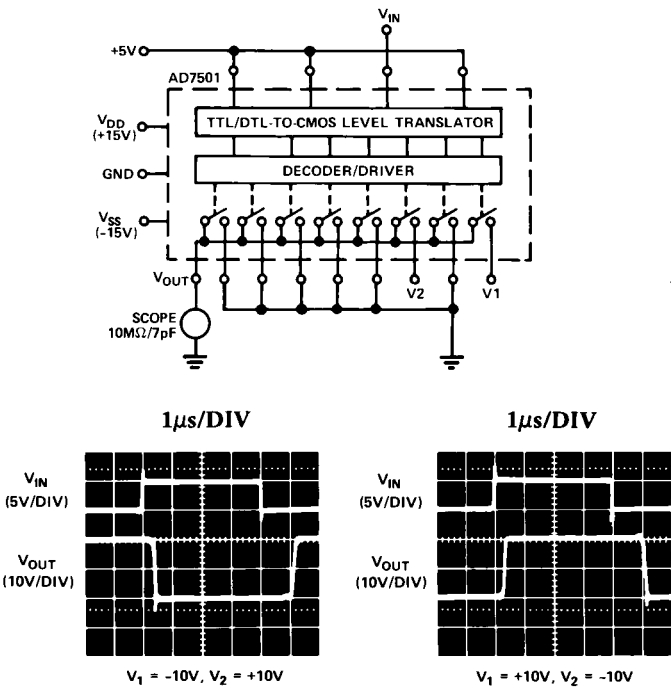
### 4. Power Dissipation



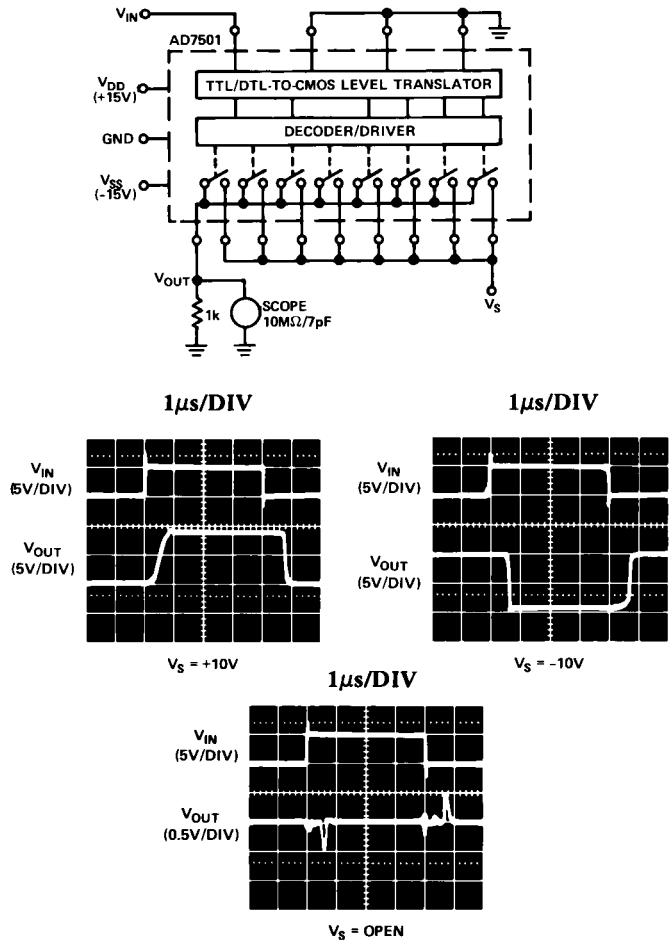
AD7501/AD7502/AD7503

TYPICAL SWITCHING CHARACTERISTICS

TEST CIRCUIT 1



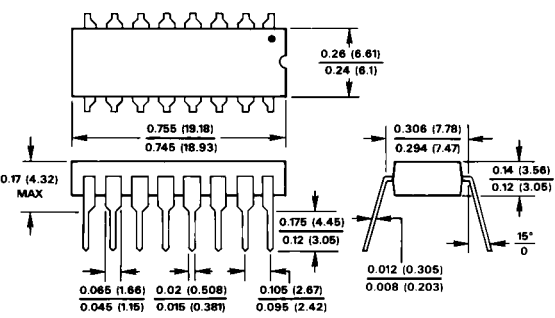
TEST CIRCUIT 2



OUTLINE DIMENSIONS

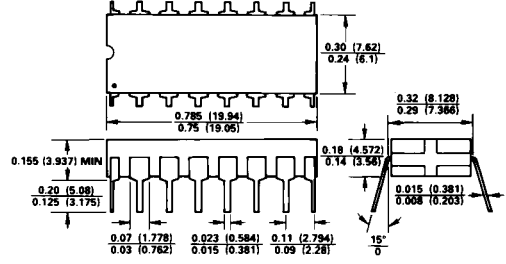
Dimensions shown in inches and (mm).

16-Pin Plastic DIP (N-16)

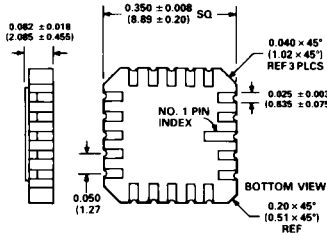


LEAD NO. 1 IDENTIFIED BY DOT OR NOTCH  
LEADS ARE SOLDER OR TIN-PLATED KOVAR OR ALLOY 42

16-Pin Cerdip (Q-16)



20-Terminal Leadless Ceramic Chip Carrier (E-20A)



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