



## 8-Channel Latchable Multiplexers

DG528/DG529

### General Description

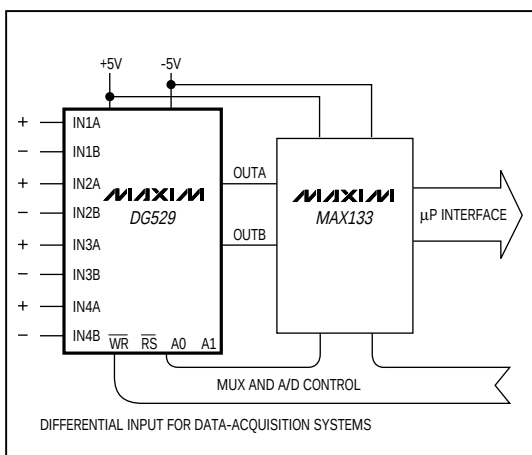
Maxim's DG528/DG529 are monolithic, 8-channel, CMOS multiplexers with on-board address and control latches that simplify design and reduce board space in microprocessor-based applications. The DG528 is a single-ended, 1-of-8 multiplexer, while the DG529 is a differential, 2-of-8 multiplexer. These devices can operate as multiplexers or demultiplexers.

The DG528/DG529 have break-before-make switching to prevent momentary shorting of the input signals. Each device operates with dual supplies ( $\pm 4.5\text{V}$  to  $\pm 20\text{V}$ ) or a single supply ( $+5\text{V}$  to  $+30\text{V}$ ). All logic inputs are TTL and CMOS compatible. The Maxim DG528/DG529 are pin and electrically compatible with the industry-standard DG528/DG529.

### Applications

Data-Acquisition Systems  
Automatic Test Equipment  
Avionics and Military Systems  
Communication Systems  
Microprocessor-Controlled Systems  
Audio-Signal Multiplexing

### Typical Operating Circuit



### Features

- ♦ Low-Power, Monolithic CMOS Design
- ♦ On-Board Address Latches
- ♦ Break-Before-Make Input Switches
- ♦ TTL and CMOS Logic Compatible
- ♦ Microprocessor-Bus Compatible
- ♦  $r_{DS(ON)} < 400\Omega$
- ♦ Pin and Electrically Compatible with the Industry-Standard DG528/DG529 and ADG528/ADG529

### Ordering Information

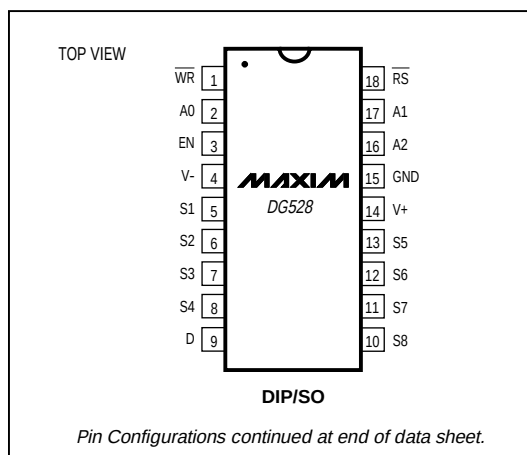
| PART     | TEMP. RANGE     | PIN-PACKAGE    |
|----------|-----------------|----------------|
| DG528CJ  | 0°C to +70°C    | 18 Plastic DIP |
| DG528CWN | 0°C to +70°C    | 18 Wide SO     |
| DG528CK  | 0°C to +70°C    | 18 Cerdip      |
| DG528C/D | 0°C to +70°C    | Dice*          |
| DG528DJ  | -40°C to +85°C  | 18 Plastic DIP |
| DG528DN  | -40°C to +85°C  | 20 PLCC        |
| DG528EWN | -40°C to +85°C  | 18 Wide SO     |
| DG528DK  | -40°C to +85°C  | 18 Cerdip      |
| DG528AZ  | -55°C to +125°C | 20 LCC**       |
| DG528AK  | -55°C to +125°C | 18 Cerdip**    |

Ordering Information continued at end of data sheet.

\* Contact factory for dice specifications.

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

### Pin Configurations



Maxim Integrated Products 1

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## 8-Channel Latchable Multiplexers

### ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-  
 V+ .....+44V  
 GND .....+25V  
 Digital Inputs V<sub>S</sub>, V<sub>D</sub> .....V- -2V to V+ +2V  
 or 20mA, whichever occurs first.  
 Current (any terminal, except S or D) .....30mA  
 Continuous Current, S or D .....  
 Peak Current, S or D .....20mA  
 (pulsed at 1ms, 10% duty cycle max) .....50mA  
 Continuous Power Dissipation (T<sub>A</sub> = +70°C) (Note 1)  
 18-Pin Plastic DIP (derate 11.11mW/°C above +70°C) ...889mW

18-Pin Wide SO (derate 9.52mW/°C above +70°C) ....762mW  
 18-Pin Cerdip (derate 10.53mW/°C above +70°C)....842mW  
 20-Pin PLCC (derate 10.00mW/°C above +70°C) .....800mW  
 20-Pin LCC (derate 9.09mW/°C above +70°C) .....727mW  
 Operating Temperature Ranges  
 DG52\_C\_ .....0°C to +70°C  
 DG52\_D\_/E\_ .....-40°C to +85°C  
 DG52\_A\_ .....-55°C to +125°C  
 Storage Temperature Range .....-65°C to +150°C  
 Lead Temperature (soldering, 10sec) .....+300°C

**Note 1:** All leads are soldered or welded to PC board.

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+ = 15V, V- = -15V, V<sub>EN</sub> = 2.4V, W<sub>R</sub> = 0V, R<sub>S</sub> = 2.4V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

| PARAMETER                                                      | SYMBOL               | CONDITIONS                                                                                                     |                                          | DG52_A                            |        |        | DG52_C/D/E |        |        | UNITS |    |
|----------------------------------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------------|------------------------------------------|-----------------------------------|--------|--------|------------|--------|--------|-------|----|
|                                                                |                      |                                                                                                                |                                          | MIN                               | TYP    | MAX    | MIN        | TYP    | MAX    |       |    |
| SWITCH                                                         |                      |                                                                                                                |                                          |                                   |        |        |            |        |        |       |    |
| Analog-Signal Range                                            | VANALOG              | (Note 2)                                                                                                       |                                          | -15                               |        | 15     | -15        |        | 15     | V     |    |
| Drain-Source On-Resistance                                     | r <sub>DS(ON)</sub>  | V <sub>D</sub> = ±10V, V <sub>AL</sub> = 0.8V, I <sub>S</sub> = -200μA, V <sub>AH</sub> = 2.4 (Note 3)         | T <sub>A</sub> = +25°C, T <sub>MIN</sub> | 270                               | 400    |        | 270        | 450    | Ω      |       |    |
|                                                                |                      |                                                                                                                | T <sub>A</sub> = T <sub>MAX</sub>        |                                   | 500    |        | 500        |        |        |       |    |
| Greatest Change in Drain-Source On-Resistance Between Channels | Δr <sub>DS(ON)</sub> | -10V < V <sub>S</sub> < 10V                                                                                    | T <sub>A</sub> = +25°C                   | 6                                 |        |        | 6          |        | %      |       |    |
| Source-Off Leakage Current                                     | I <sub>S(OFF)</sub>  | V <sub>EN</sub> = 0V, V <sub>S</sub> = ±10V, V <sub>D</sub> = ±10V                                             | T <sub>A</sub> = +25°C                   | -1                                | -0.005 | 1      | -5         | -0.005 | 5      | nA    |    |
|                                                                |                      |                                                                                                                | T <sub>A</sub> = T <sub>MAX</sub>        | -50                               | -0.005 | 50     | -50        | -0.005 | 50     |       |    |
| Drain-Off Leakage Current                                      | I <sub>D(OFF)</sub>  | V <sub>EN</sub> = 0V, V <sub>S</sub> = ±10V, V <sub>D</sub> = ±10V                                             | DG528                                    | T <sub>A</sub> = +25°C            | -10    | -0.015 | 10         | -20    | -0.015 | 20    | nA |
|                                                                |                      |                                                                                                                |                                          | T <sub>A</sub> = T <sub>MAX</sub> | -200   | -0.015 | 200        | -200   | -0.015 | 200   |    |
|                                                                |                      |                                                                                                                | DG529                                    | T <sub>A</sub> = +25°C            | -10    | -0.008 | 10         | -20    | -0.008 | 20    |    |
|                                                                |                      |                                                                                                                |                                          | T <sub>A</sub> = T <sub>MAX</sub> | -100   | -0.008 | 100        | -100   | -0.008 | 100   |    |
| Drain-On Leakage Current (Notes 3, 4)                          | I <sub>D(ON)</sub>   | V <sub>AH</sub> = 2.4V, V <sub>S</sub> = V <sub>D</sub> = ±10V, V <sub>AL</sub> = 0.8V, V <sub>EN</sub> = 2.4V | DG528                                    | T <sub>A</sub> = +25°C            | -10    | -0.03  | 10         | -20    | -0.03  | 20    | nA |
|                                                                |                      |                                                                                                                |                                          | T <sub>A</sub> = T <sub>MAX</sub> | -200   | -0.03  | 200        | -200   | -0.03  | 200   |    |
|                                                                |                      |                                                                                                                | DG529                                    | T <sub>A</sub> = +25°C            | -10    | -0.015 | 10         | -20    | -0.015 | 20    |    |
|                                                                |                      |                                                                                                                |                                          | T <sub>A</sub> = T <sub>MAX</sub> | -100   | -0.015 | 100        | -100   | -0.015 | 100   |    |
| INPUT                                                          |                      |                                                                                                                |                                          |                                   |        |        |            |        |        |       |    |
| Address Input Current, Input Voltage High                      | I <sub>AH</sub>      | V <sub>A</sub> = 2.4V                                                                                          | T <sub>A</sub> = +25°C                   | -1                                | -0.002 | 1      | -1         | -0.002 | 1      | μA    |    |
|                                                                |                      |                                                                                                                | T <sub>A</sub> = T <sub>MAX</sub>        | -30                               |        |        | -30        |        |        |       |    |
|                                                                |                      | V <sub>A</sub> = 15V                                                                                           | T <sub>A</sub> = +25°C                   | -1                                | -0.006 | 1      | -1         | -0.006 | 1      |       |    |
|                                                                |                      |                                                                                                                | T <sub>A</sub> = T <sub>MAX</sub>        |                                   |        | 30     |            |        | 30     |       |    |
| Address Input Current, Input Voltage Low                       | I <sub>AL</sub>      | V <sub>A</sub> = $\overline{RS}$ = $\overline{WR}$ = 0V, V <sub>EN</sub> = 0V or 2.4V                          | T <sub>A</sub> = +25°C                   | -1                                | -0.002 | 1      | -1         | -0.002 | 1      | μA    |    |
|                                                                |                      |                                                                                                                | T <sub>A</sub> = T <sub>MAX</sub>        | -30                               | -0.01  |        | -30        | -0.01  |        |       |    |

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| PARAMETER                                      | SYMBOL                                         | CONDITIONS                                                                                                         |                        | DG52_A                 |       |      | DG52_C/D/E |      |     | UNITS |
|------------------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|------------------------|------------------------|-------|------|------------|------|-----|-------|
|                                                |                                                |                                                                                                                    |                        | MIN                    | TYP   | MAX  | MIN        | TYP  | MAX |       |
| DYNAMIC                                        |                                                |                                                                                                                    |                        |                        |       |      |            |      |     |       |
| Switching Time of Multiplexer                  | t <sub>TRANS</sub>                             | Figure 1                                                                                                           | T <sub>A</sub> = +25°C |                        | 0.4   | 1    | 1.5        |      | μs  |       |
| Break-Before-Make Interval                     | t <sub>OPEN</sub>                              | Figure 2                                                                                                           | T <sub>A</sub> = +25°C |                        | 0.2   | 0.2  |            | μs   |     |       |
| Enable, Write Turn-On Time                     | t <sub>ON</sub> (EN, $\overline{\text{WR}}$ )  | Figures 3, 4                                                                                                       | T <sub>A</sub> = +25°C |                        | 1.0   | 1.5  | 1.5        |      | μs  |       |
| Enable, Reset Turn-Off Time                    | t <sub>OFF</sub> (EN, $\overline{\text{RS}}$ ) | Figures 3, 5                                                                                                       | T <sub>A</sub> = +25°C |                        | 0.4   | 1    | 1.5        |      | μs  |       |
| Charge Injection                               | Q                                              | Figure 6                                                                                                           | T <sub>A</sub> = +25°C |                        | 4     | 4    |            | pC   |     |       |
| Off Isolation                                  | O <sub>IRR</sub>                               | V <sub>EN</sub> = 0V, R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 15pF, V <sub>S</sub> = 7V <sub>RMS</sub> , f = 500kHz | T <sub>A</sub> = +25°C |                        | 68    | 68   |            | dB   |     |       |
| Logic-Input Capacitance                        | C <sub>IN</sub>                                | f = 1MHz                                                                                                           | T <sub>A</sub> = +25°C |                        | 2.5   | 2.5  |            | pF   |     |       |
| Source-Off Capacitance                         | C <sub>S</sub> (OFF)                           | V <sub>EN</sub> = 0V, f = 140kHz, V <sub>S</sub> = 0V                                                              | T <sub>A</sub> = +25°C |                        | 5     | 5    |            | pF   |     |       |
| Drain-Off Capacitance                          | C <sub>D</sub> (OFF)                           | V <sub>EN</sub> = 0V, f = 140kHz, V <sub>S</sub> = 0V                                                              | DG528                  | T <sub>A</sub> = +25°C | 25    | 25   |            | pF   |     |       |
|                                                |                                                | DG529                                                                                                              | T <sub>A</sub> = +25°C | 12                     | 12    |      |            |      |     |       |
| SUPPLY                                         |                                                |                                                                                                                    |                        |                        |       |      |            |      |     |       |
| Positive Supply Current                        | I+                                             | V <sub>EN</sub> = V <sub>AH</sub> = 0V                                                                             |                        | T <sub>A</sub> = +25°C | 0.003 | 2.5  | 0.003      | 2.5  | mA  |       |
| Negative Supply Current                        | I-                                             | V <sub>EN</sub> = V <sub>AH</sub> = 0V                                                                             |                        | T <sub>A</sub> = +25°C | -1.5  | 0.01 | -1.5       | 0.01 | mA  |       |
| MINIMUM INPUT TIMING                           |                                                |                                                                                                                    |                        |                        |       |      |            |      |     |       |
| WR Pulse Width                                 | t <sub>WW</sub>                                | Figure 7                                                                                                           |                        |                        | 300   | 150  | 300        | 15   | ns  |       |
| AX, EN Data Valid to $\overline{\text{WR}}$    | t <sub>DW</sub>                                | (Stabilization Time) Figure 7                                                                                      |                        |                        | 180   | 120  | 180        | 12   | ns  |       |
| AX, EN Data Valid after $\overline{\text{WR}}$ | t <sub>WD</sub>                                | (Hold Time) Figure 7                                                                                               |                        |                        | 30    | 10   | 30         | 10   | ns  |       |
| $\overline{\text{RS}}$ Pulse Width             | t $\overline{\text{RS}}$                       | Figure 7; V <sub>S</sub> = 5V (Note 5)                                                                             |                        |                        | 500   | 150  | 500        | 150  | ns  |       |

**Note 2:** Guaranteed by design.

**Note 3:** Sequence each switch on.

**Note 4:** I<sub>D(ON)</sub> is leakage from driver into on switch.

**Note 5:** Reset pulse period must be at least 50μs during or after power-on.

DG528/DG529

## 8-Channel Latchable Multiplexers

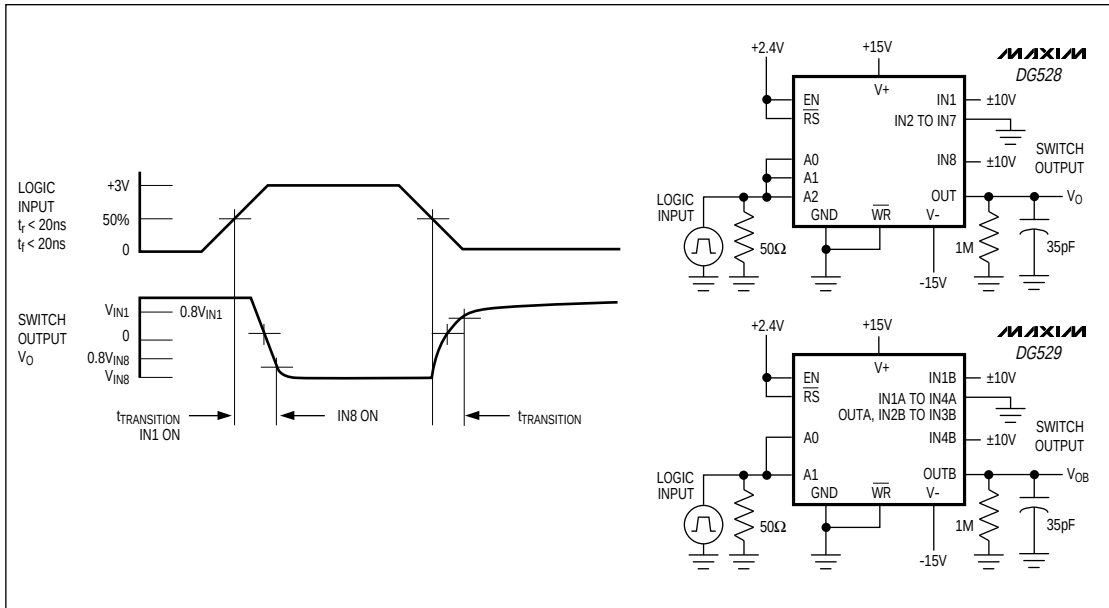


Figure 1. Transition-Time Test Circuits

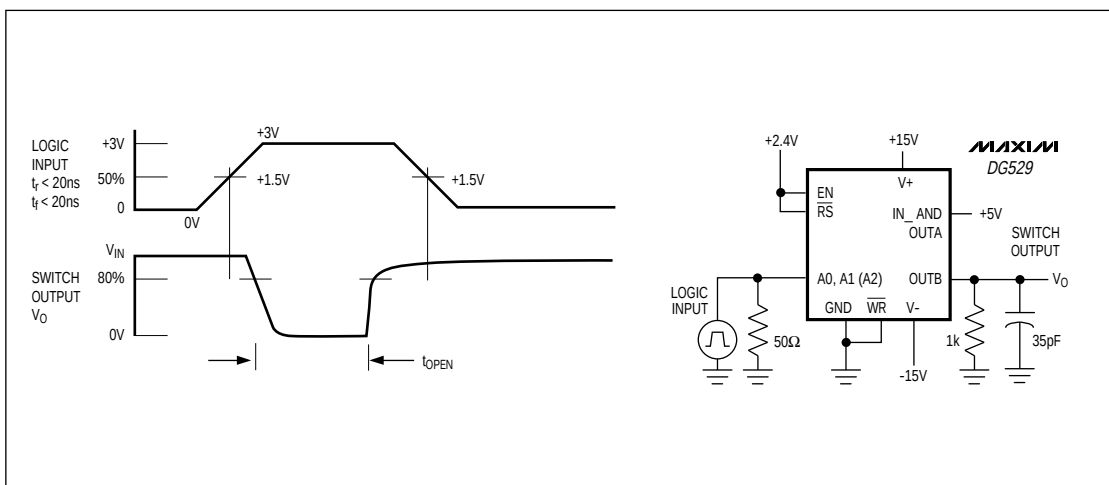


Figure 2. Open-Time (B.B.M.) Interval Test Circuit

## 8-Channel Latchable Multiplexers

DG528/DG529

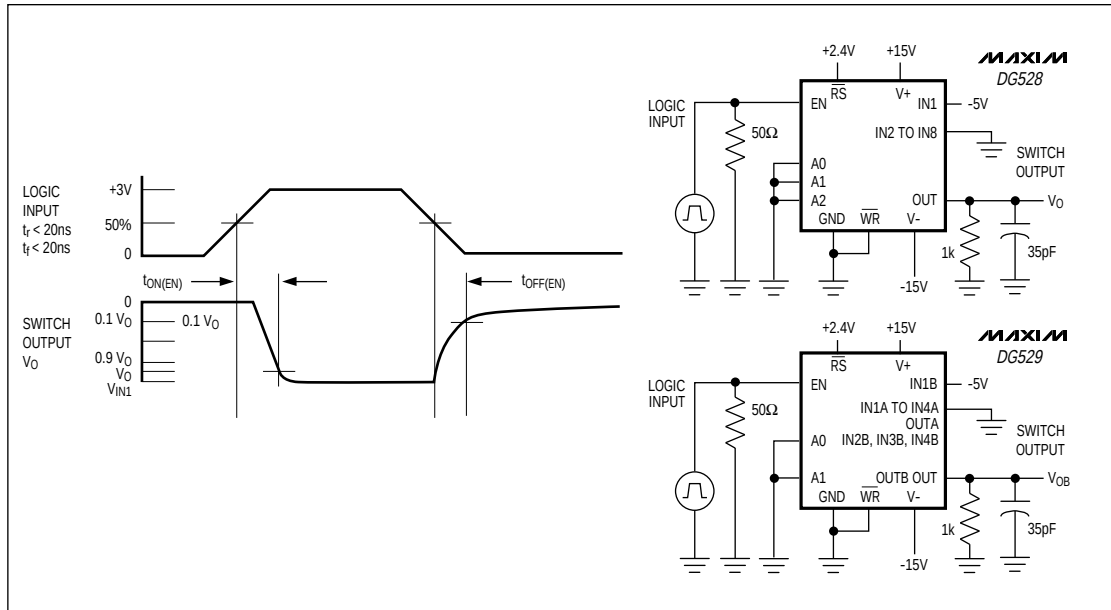


Figure 3. Enable t<sub>ON</sub>/t<sub>OFF</sub> Time Test Circuit

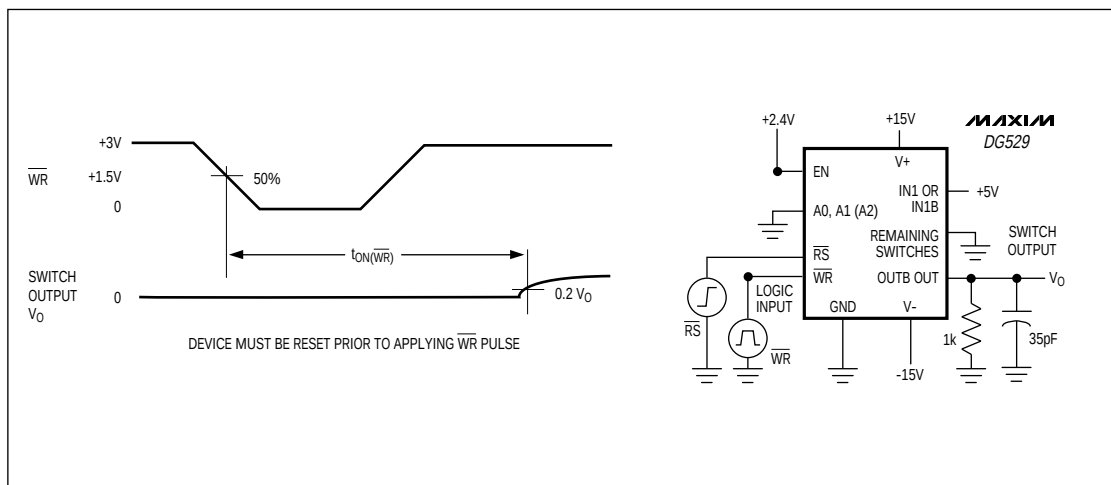


Figure 4. Write Turn-On Time t<sub>ON(WR)</sub> Test Circuit

## 8-Channel Latchable Multiplexers

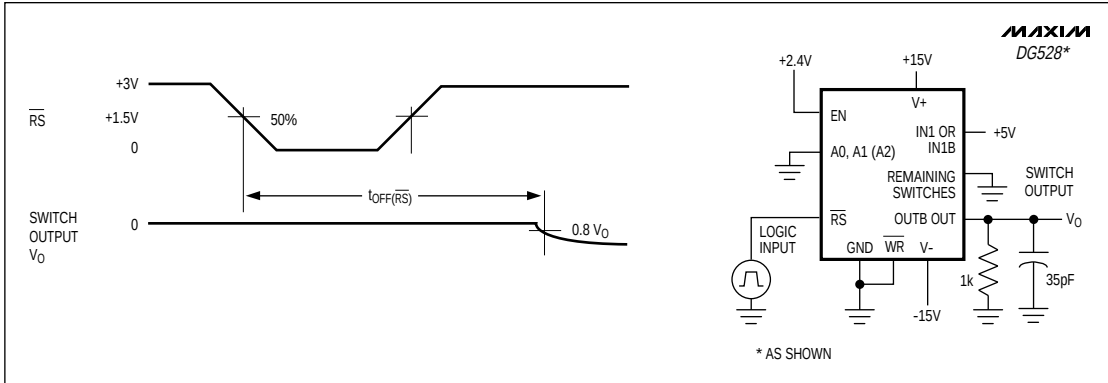


Figure 5. Reset Turn-Off Time  $t_{OFF}(\overline{RS})$  Test Circuit

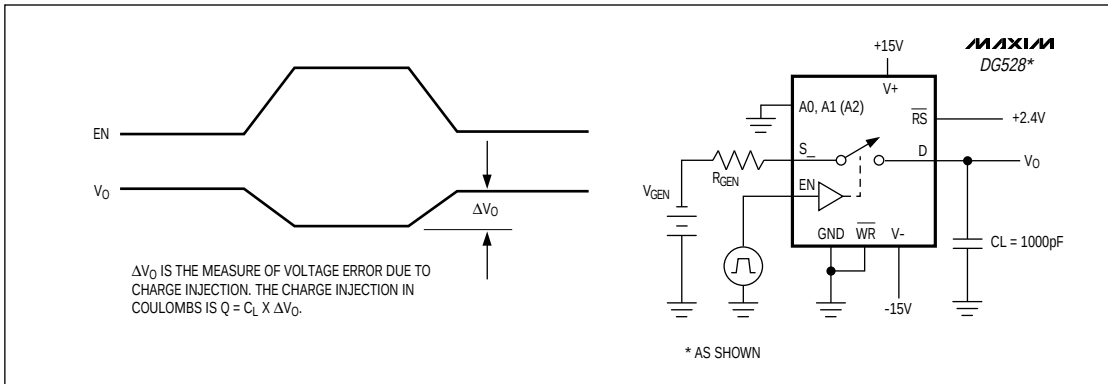


Figure 6. Charge-Injection Test Circuit

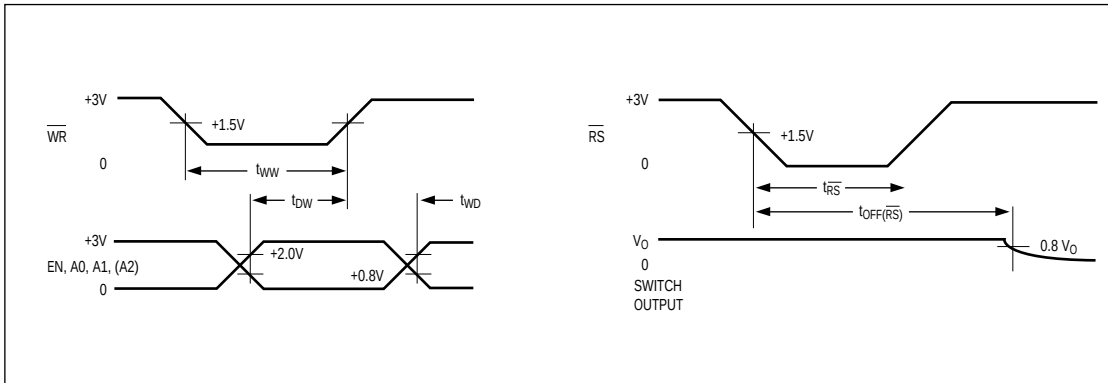


Figure 7. Typical Timing Diagrams for DG528/DG529

## 8-Channel Latchable Multiplexers

DG528/DG529

**Table 1. DG528 Logic States**

| A2                           | A1 | A0 | EN | $\overline{WR}$ | $\overline{RS}$ | ON SWITCH                           |
|------------------------------|----|----|----|-----------------|-----------------|-------------------------------------|
| <b>Latching</b>              |    |    |    |                 |                 |                                     |
| X                            | X  | X  | X  | $\uparrow$      | 1               | Maintains previous switch condition |
| <b>Reset</b>                 |    |    |    |                 |                 |                                     |
| X                            | X  | X  | X  | X               | 0               | None (latches cleared)              |
| <b>Transparent Operation</b> |    |    |    |                 |                 |                                     |
| X                            | X  | X  | 0  | 0               | 1               | None                                |
| 0                            | 0  | 0  | 1  | 0               | 1               | 1                                   |
| 0                            | 0  | 1  | 1  | 0               | 1               | 2                                   |
| 0                            | 1  | 0  | 1  | 0               | 1               | 3                                   |
| 0                            | 1  | 1  | 1  | 0               | 1               | 4                                   |
| 1                            | 0  | 0  | 1  | 0               | 1               | 5                                   |
| 1                            | 0  | 1  | 1  | 0               | 1               | 6                                   |
| 1                            | 1  | 0  | 1  | 0               | 1               | 7                                   |
| 1                            | 1  | 1  | 1  | 0               | 1               | 8                                   |

**Table 2. DG529 Logic States**

| A1                           | A0 | EN | $\overline{WR}$ | $\overline{RS}$ | ON SWITCH                           |
|------------------------------|----|----|-----------------|-----------------|-------------------------------------|
| <b>Latching</b>              |    |    |                 |                 |                                     |
| X                            | X  | X  | $\uparrow$      | 1               | Maintains previous switch condition |
| <b>Reset</b>                 |    |    |                 |                 |                                     |
| X                            | X  | X  | X               | 0               | None (latches cleared)              |
| <b>Transparent Operation</b> |    |    |                 |                 |                                     |
| X                            | X  | 0  | 0               | 1               | None                                |
| 0                            | 0  | 1  | 0               | 1               | 1                                   |
| 0                            | 1  | 1  | 0               | 1               | 2                                   |
| 1                            | 0  | 1  | 0               | 1               | 3                                   |
| 1                            | 1  | 1  | 0               | 1               | 4                                   |

**Note:** Logic "1":  $V_{AH} \geq 2.4V$ , Logic "0":  $V_{AL} \leq 0.8V$ .

### Detailed Description

The internal structures of the DG528/DG529 include translators for the A2/A1/A0/EN/ $\overline{WR}$ / $\overline{RS}$  digital inputs, latches, and a decode section for channel selection (Truth Tables). The gate structures consist of parallel combinations of N and P MOSFETs.

WRITE ( $\overline{WR}$ ) and RESET ( $\overline{RS}$ ) strobes are provided for interfacing with  $\mu P$ -bus lines (Figure 9), alleviating the need for the  $\mu P$  to provide constant address inputs to the mux to hold a particular channel.

When the  $\overline{WR}$  strobe is in the low state (less than 0.8V) and the  $\overline{RS}$  strobe is in the high state (greater than 2.4V), the muxes are in the transparent mode—they act similarly to nonlatching devices, such as the DG508A/DG509A or the HI508/HI509.

When the  $\overline{WR}$  goes high, the previous BCD address input is latched and held in that state indefinitely. To pull the mux out of this state, either  $\overline{WR}$  must be taken

low to the transition state, or  $\overline{RS}$  must be taken low to turn off all channels.

$\overline{RS}$  turns off all channels when it is low, which resets channel selection to the channel 1 mode.

The DG528/DG529 work with both single and dual supplies and function over the +5V to +30V single-supply range. For example, with a single +15V power supply, analog signals in the 0V to +15V range can be switched normally. If negative signals around 0V are expected, a negative supply is needed. However, only -5V is needed to normally switch signals in the -5V to +15V range (-5V, +15V supplies). No current is drawn from the negative supply, so Maxim's MAX635 DC-DC converter is an ideal choice.

The EN latch allows all switches to be turned off under program control. This is useful when two or more DG528s are cascaded to build 16-line and larger analog-signal multiplexers.

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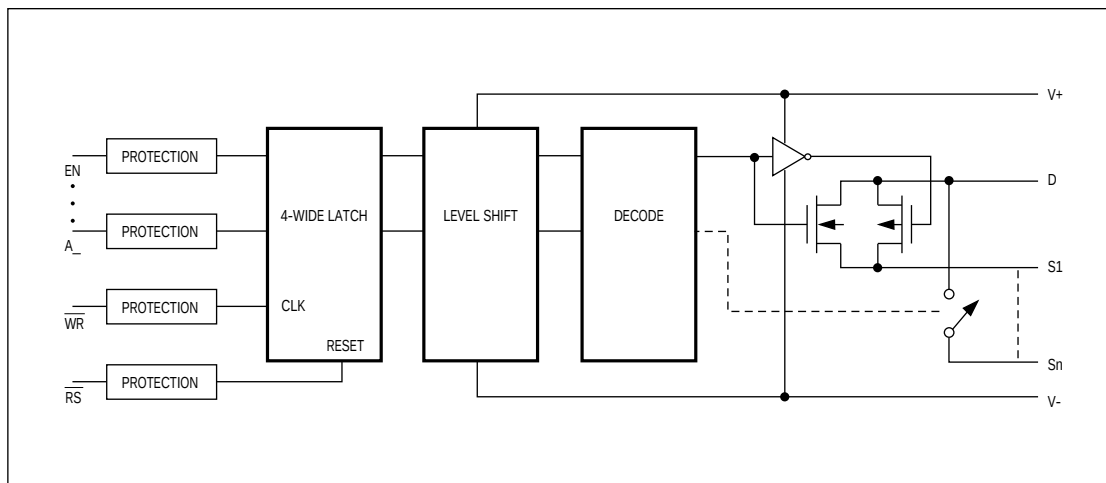


Figure 8. Simplified Internal Structure

### Applications

#### Operation with Supply Voltages Other Than $\pm 15V$

Maxim guarantees the DG528/DG529 for operation from  $\pm 4.5V$  to  $\pm 20V$  supplies. The switching delays increase by about a factor of two at  $\pm 5V$ , and break-before-make action is preserved.

The DG528/DG529 can operate with a single  $+5V$  to  $+30V$  supply as well as asymmetrical power supplies like  $+15V$  and  $-5V$ . The digital threshold will remain approximately  $1.6V$  above the GND pin, and the analog characteristics such as  $r_{DS(ON)}$  are determined by the total voltage difference between  $V+$  and  $V-$ . Connect  $V-$  to  $0V$  when operating with a  $+5V$  to  $+30V$  single supply.

#### Digital Interface Levels

The typical digital threshold of both the address lines and EN is  $1.6V$  with a temperature coefficient of approximately  $-3mV/^{\circ}C$ , ensuring compatibility with TTL logic over the temperature range. The digital threshold is relatively independent of the power-supply voltages, going from a typical  $1.6V$  when  $V+$  is  $15V$  to  $1.5V$  typical with  $V+ = 5V$ . Therefore, Maxim's DG528/DG529 operate with standard TTL logic levels, even with  $\pm 5V$  power supplies. In all cases, EN's threshold is the same as the other logic inputs and is referenced to GND.

The digital inputs can also be driven with CMOS logic levels swinging from either  $V+$  to  $V-$  or from  $V+$  to GND. The digital input current is just a few nanoamps of leakage at all input-voltage levels with a guaranteed maximum of  $1\mu A$ . The digital inputs are protected from ESD by a  $30V$  zener diode between the input and  $V+$  and can be driven  $\pm 2V$  beyond the supplies without drawing excessive current.

# 8-Channel Latchable Multiplexers

DG528/DG529

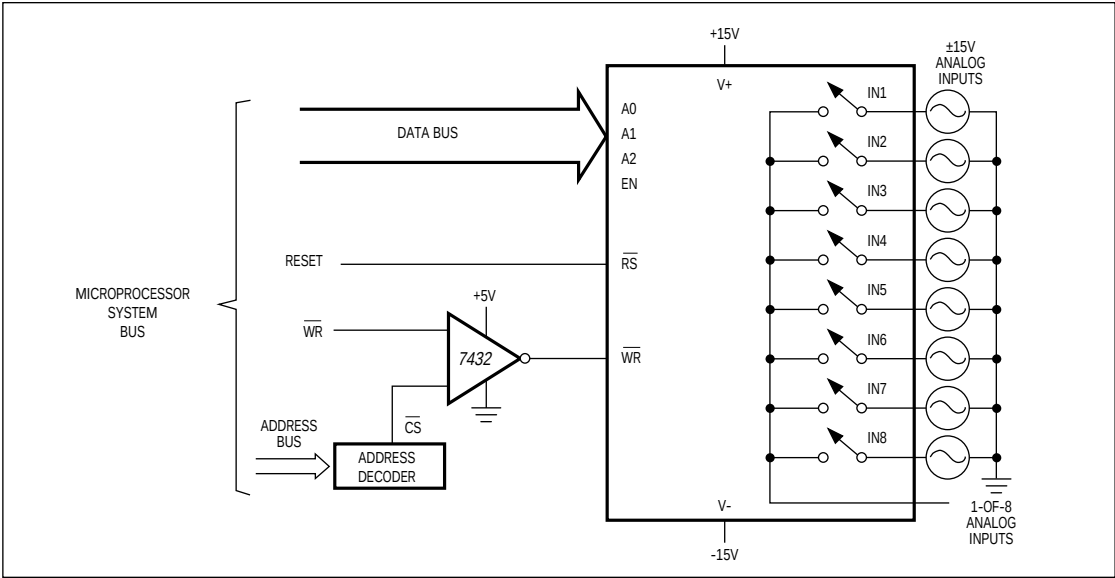
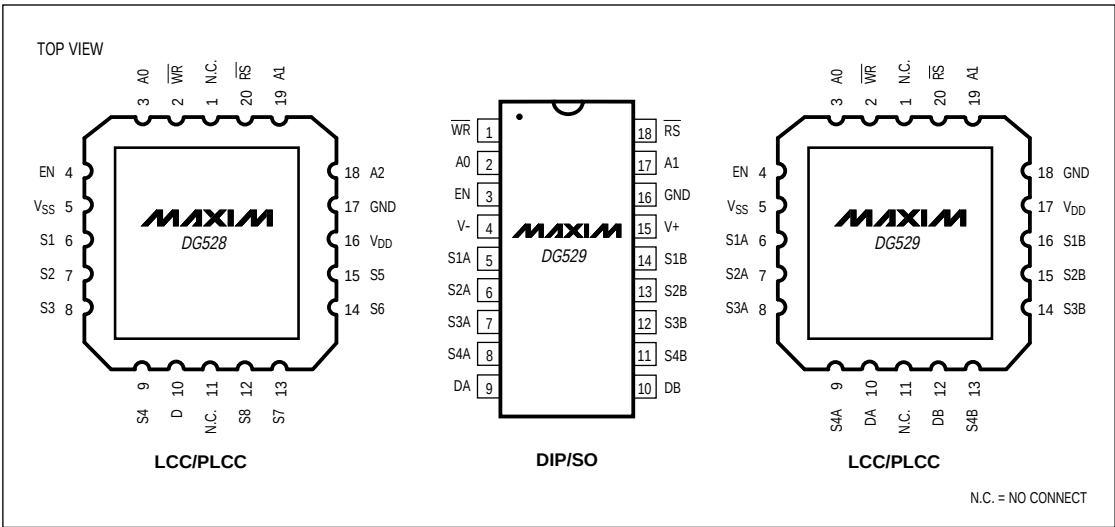


Figure 9. Bus Interface

## Pin Configurations (continued)



## 8-Channel Latchable Multiplexers

DG528/DG529

### \_Ordering Information (continued)

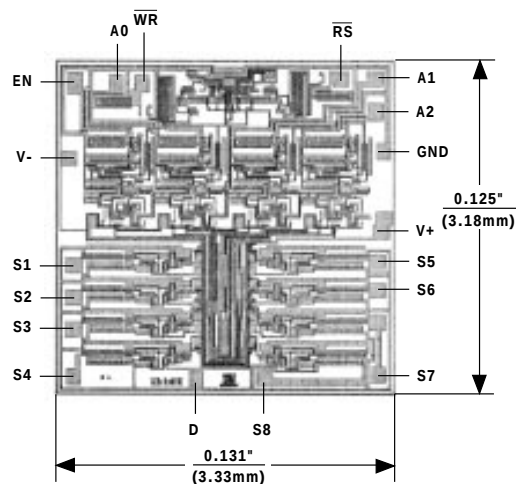
| PART     | TEMP. RANGE     | PIN-PACKAGE    |
|----------|-----------------|----------------|
| DG529CJ  | 0°C to +70°C    | 18 Plastic DIP |
| DG529CWN | 0°C to +70°C    | 18 Wide SO     |
| DG529CK  | 0°C to +70°C    | 18 CERDIP      |
| DG529C/D | 0°C to +70°C    | Dice*          |
| DG529DJ  | -40°C to +85°C  | 18 Plastic DIP |
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| DG529DK  | -40°C to +85°C  | 18 CERDIP      |
| DG529AZ  | -55°C to +125°C | 20 LCC**       |
| DG529AK  | -55°C to +125°C | 18 CERDIP**    |

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

### Chip Topographies

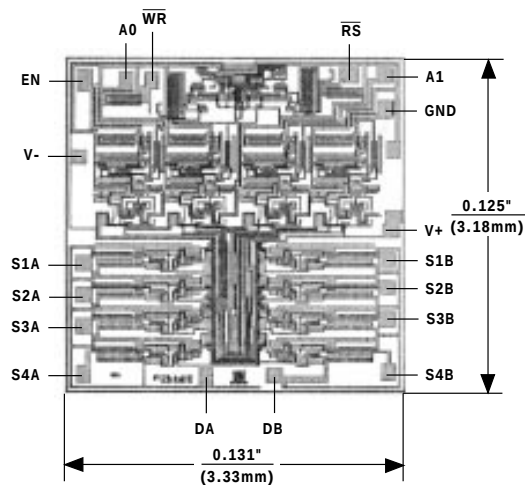
DG528



TRANSISTOR COUNT: 200

SUBSTRATE CONNECTED TO V+

DG529



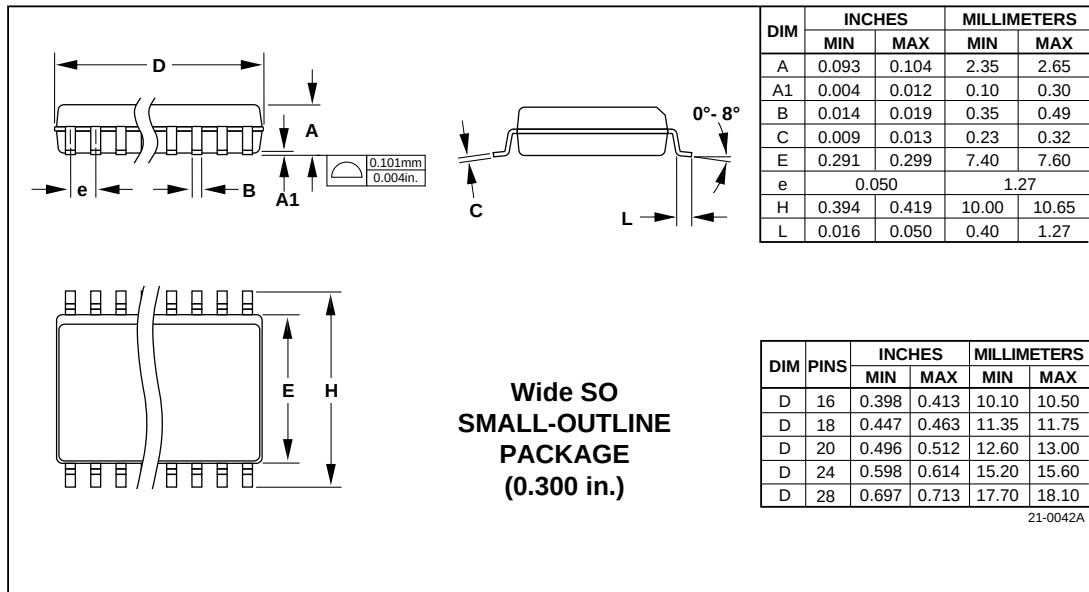
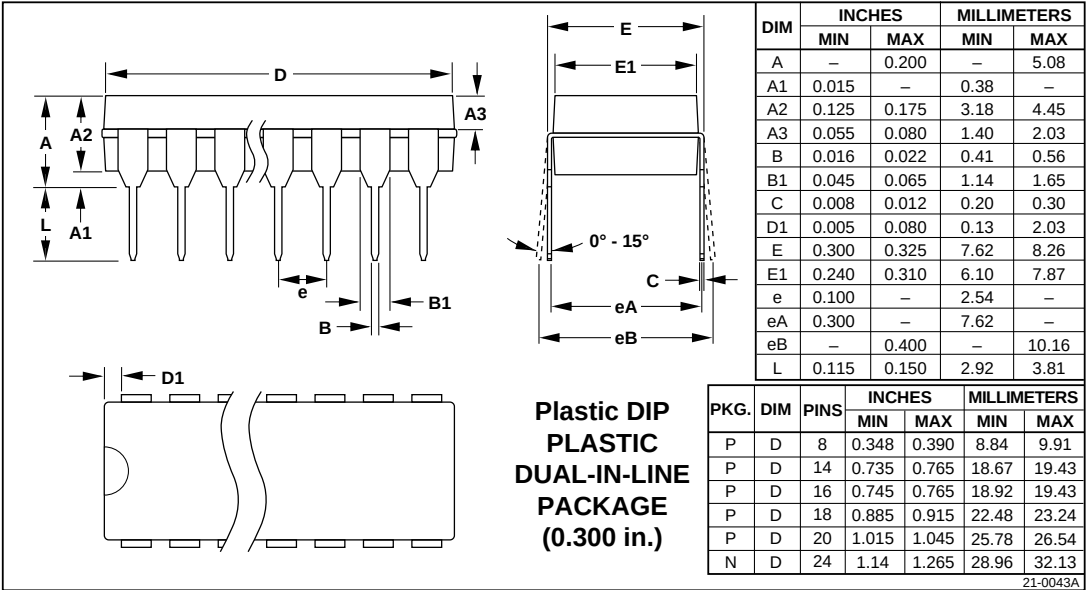
TRANSISTOR COUNT: 200

SUBSTRATE CONNECTED TO V+

# 8-Channel Latchable Multiplexers

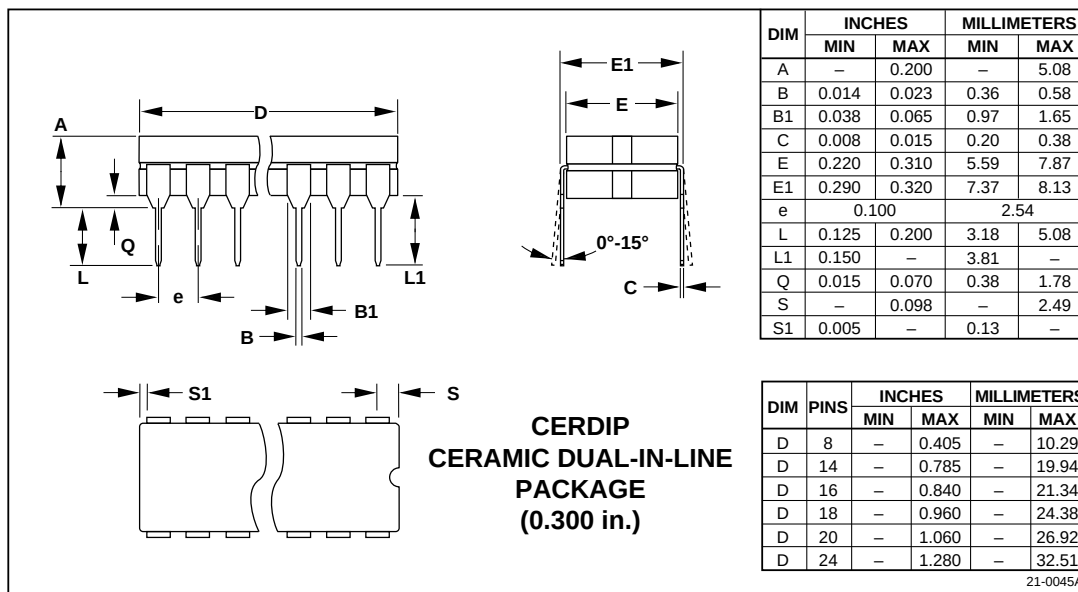
## Package Information

DG528/DG529



# 8-Channel Latchable Multiplexers

## Package Information (continued)



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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