

# Monolithic CMOS Analog Multiplexers

## General Description

Maxim's DG508A and DG509A are monolithic CMOS analog multiplexers (muxes): the DG508A is a single 8-channel (1-of-8) mux, and the DG509A is a differential 4-channel (2-of-8) mux.

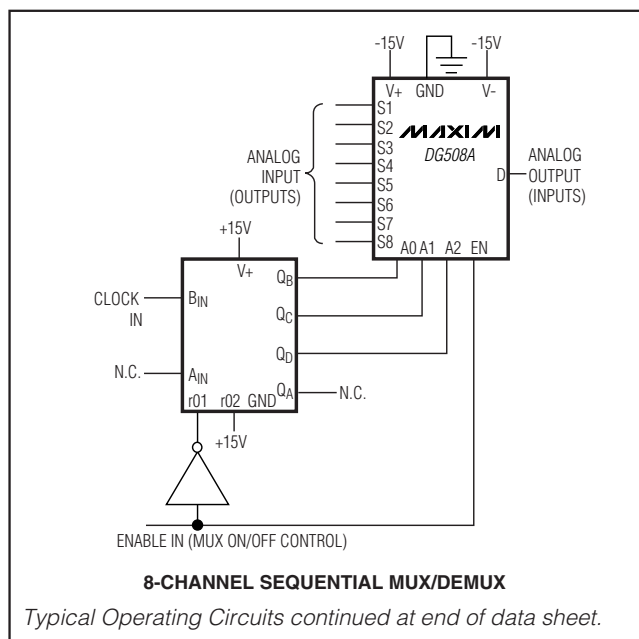
Both devices guarantee break-before-make switching. Maxim guarantees these muxes will not latch up if the power supplies are turned off with the input signals still present. Maxim also guarantees continuous operation when these devices are powered by supplies ranging from  $\pm 4.5\text{V}$  to  $\pm 18\text{V}$ .

The DG508A/DG509A are plug-in upgrades for the industry-standard DG508A/DG509A, respectively. Maxim's parts have faster enable switching times and significantly lower leakage currents. The DG508A/DG509A also consume significantly lower power, making them ideal for portable equipment.

## Applications

Control Systems  
Data Logging Systems  
Aircraft Heads-Up Displays  
Data-Acquisition Systems  
Signal Routing

## Typical Operating Circuits



## Features

- ◆ Improved Second Source
- ◆ Operate from  $\pm 4.5\text{V}$  to  $\pm 18\text{V}$  Supplies
- ◆ Symmetrical, Bidirectional Operation
- ◆ Logic and Enable Inputs, TTL and CMOS Compatible
- ◆ Latchup-Proof Construction
- ◆ Monolithic, Low-Power CMOS Design

## Ordering Information

| PART        | TEMP RANGE      | PIN-PACKAGE    |
|-------------|-----------------|----------------|
| DG508ACJ    | 0°C to +70°C    | 16 Plastic DIP |
| DG508ACWE   | 0°C to +70°C    | 16 Wide SO     |
| DG508AC/D   | 0°C to +70°C    | Dice*          |
| DG508ABK    | -20°C to +85°C  | 16 CERDIP      |
| DG508ADJ    | -40°C to +85°C  | 16 Plastic DIP |
| DG508ADY    | -40°C to +85°C  | 16 Narrow SO   |
| DG508AEWE   | -40°C to +85°C  | 16 Wide SO     |
| DG508AAK    | -55°C to +125°C | 16 CERDIP      |
| DG508AMY/PR | -55°C to +125°C | 16 Narrow SO   |
| DG509ACJ    | 0°C to +70°C    | 16 Plastic DIP |
| DG509ACWE   | 0°C to +70°C    | 16 Wide SO     |
| DG509AC/D   | 0°C to +70°C    | Dice*          |
| DG509ABK    | -20°C to +85°C  | 16 CERDIP      |
| DG509ADJ    | -40°C to +85°C  | 16 Plastic DIP |
| DG509ADY    | -40°C to +85°C  | 16 Narrow SO   |
| DG509AEWE   | -40°C to +85°C  | 16 Wide SO     |
| DG509AAK    | -55°C to +125°C | 16 CERDIP      |
| DG509AMY/PR | -55°C to +125°C | 16 Narrow SO   |

Devices are available in a lead(Pb)-free/RoHS-compliant package (except CERDIP). Specify lead-free by adding a plus (+) to the part number when ordering.

\*Contact factory for dice specifications.

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## ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-

|  |   |
|--|---|
| V+ .....   | +44V  |
| GND .....  | +25V  |
| Digital Inputs, V <sub>S</sub> and V <sub>D</sub> (Note 1) ..... | -2V to (V+ + 2V)<br>or 20mA, whichever occurs first |
| Current (any terminal, except S or D) .....                      | 30mA  |
| Continuous Current, S or D .....                                 | 20mA  |
| Peak Current, S or D (pulsed at 1ms, 10% duty cycle max) ..      | 40mA  |
| Continuous Power Dissipation (T <sub>A</sub> = +70°C)            |   |
| Plastic DIP (derate 10.53mW/°C above +70°C) .....                | 842mW   |
| Narrow SO (derate 8.70mW/°C above +70°C) .....                   | 696mW   |
| Wide SO (derate 9.52mW/°C above +70°C) .....                     | 762mW   |
| CERDIP (derate 10.00mW/°C above +70°C) .....                     | 800mW   |

Operating Temperature Ranges:

|   |                 |
|---|-----------------|
| DG50_ACJ/CWE .....                                      | 0°C to +70°C    |
| DG50_ABK .....  | -20°C to +85°C  |
| DG50_ADJ/DY/EWE .....                                   | -40°C to +85°C  |
| DG50_AAK/MY .....                                       | -55°C to +125°C |
| Storage Temperature Range .....                         | -65°C to +150°C |
| Lead Temperature (soldering, 10s) .....                 | +300°C          |
| Soldering Temperature (reflow)                          |                 |
| PDIP, Wide SO, Narrow SO, CERDIP containing lead(Pb) .. | +240°C          |
| PDIP, Wide SO, Narrow SO lead(Pb)-free .....            | +260°C          |

**Note 1:** Signals on S<sub>-</sub> or D<sub>-</sub> exceeding V+ or V- are clamped by internal diodes. Limit forward-diode current to maximum current ratings

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>GND</sub> = 0V, T<sub>A</sub> = +25°C, unless otherwise noted.)

| PARAMETER  | SYMBOL               | CONDITIONS   | DG508AA/M<br>DG509AA/M                           |     |       | DG508AD/E/B/C<br>DG509AD/E/B/C |       |        | UNITS |
|--|----------------------|--|--|-----|-------|--------------------------------|-------|--------|-------|
|  |                      |  | MIN  | TYP | MAX   | MIN                            | TYP   | MAX    |       |
| <b>SWITCH</b>  |                      |  |  |     |       |                                |       |        |       |
| Analog Signal  | V <sub>ANALOG</sub>  |  | -15  |     | +15   | -15                            |       | +15    | V     |
| Drain-Source On-Resistance                                     | R <sub>DS(ON)</sub>  | Sequence each switch on,<br>V <sub>A_L</sub> = 0.8V,<br>V <sub>A_H</sub> = 2.4V (Note 4)   | V <sub>D</sub> = 10V,<br>I <sub>S</sub> = -200μA |     | 170   | 400                            | 170   | 450    | Ω     |
|  |                      |  | V <sub>D</sub> = -10V,<br>I <sub>S</sub> = 200μA |     | 130   | 400                            | 130   | 450    |       |
| Greatest Change in Drain-Source On-Resistance Between Channels | ΔR <sub>DS(ON)</sub> | $\Delta R_{DS(ON)} = \left( \frac{R_{DS(ON) \max} - R_{DS(ON) \min}}{R_{DS(ON)}} \right)$  |  |     | 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      |     | 0.002 | 0.5                            | 0.002 | 1      | nA    |
|  |                      |  | V <sub>S</sub> = -10V, V <sub>D</sub> = 10V      |     | -0.5  | -0.005                         | -1    | -0.005 |       |
| Drain Off-Leakage Current                                      | DG508A               | V <sub>EN</sub> = 0V   | V <sub>D</sub> = 10V, V <sub>S</sub> = -10V      |     | 0.01  | 2                              | 0.01  | 5      | nA    |
|  |                      |  | V <sub>D</sub> = -10V, V <sub>S</sub> = 10V      |     | -2    | -0.015                         | -5    | -0.015 |       |
|  | DG509A               |  | V <sub>D</sub> = 10V, V <sub>S</sub> = -10V      |     | 0.005 | 2                              | 0.005 | 5      |       |
|  |                      |  | V <sub>D</sub> = -10V, V <sub>S</sub> = 10V      |     | -2    | -0.008                         | -5    | -0.008 |       |
| Drain On-Leakage Current                                       | DG508A               | Sequence each switch on,<br>V <sub>A_L</sub> = 0.8V<br>V <sub>A_H</sub> = 2.4V<br>(Note 2) | V <sub>S(all)</sub> = V <sub>D</sub> = 10V       |     | 0.015 | 2                              | 0.015 | 5      | nA    |
|  |                      |  | V <sub>S(all)</sub> = V <sub>D</sub> = -10V      |     | -2    | -0.03                          | -5    | -0.03  |       |
|  | DG509A               |  | V <sub>S(all)</sub> = V <sub>D</sub> = 10V       |     | 0.007 | 2                              | 0.007 | 5      |       |
|  |                      |  | V <sub>S(all)</sub> = V <sub>D</sub> = -10V      |     | -2    | -0.015                         | -5    | -0.015 |       |

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**DG508A/DG509A**

## ELECTRICAL CHARACTERISTICS (continued)

(V+ = 15V, V- = -15V, VGND = 0V, TA = +25°C, unless otherwise noted.)

| PARAMETER                                      | SYMBOL      | CONDITIONS   | DG508AA/M<br>DG509AA/M        |       |       | DG508AD/E/B/C<br>DG509AD/E/B/C |        |        | UNITS |
|--|-------------|--|-------------------------------|-------|-------|--------------------------------|--------|--------|-------|
|  |             |  | MIN                           | TYP   | MAX   | MIN                            | TYP    | MAX    |       |
| <b>LOGIC INPUT</b>                             |             |  |                               |       |       |                                |        |        |       |
| Logic Input Current,<br>Input Voltage High     | IAH         | VA_ = 2.4V   |                               | -10   | -     | 10                             | -0.002 | μA     |       |
|  |             | VA_ = 15V  |                               | 0.006 | 10    | 0.006                          | 10     |        |       |
| Logic Input Current,<br>Input Voltage Low      | IAL         | All VA_ = 0V   | VEN = 2.4V                    |       | -10   | -                              | 10     | -0.002 | μA    |
|  |             |  | VEN = 0V                      |       | -10   | -                              | -10    | -0.002 |       |
| <b>DYNAMIC</b>                                 |             |  |                               |       |       |                                |        |        |       |
| Multiplexer Switching                          | ttransition | Figure 1   |                               | 0.6   | 1.0   | 0.6                            | 1.0    | μs     |       |
| Break-Before-Make<br>Interval                  | tOPEN       | Figure 3   |                               | 0.2   |       | 0.2                            |        | μs     |       |
| Enable Turn-On Time                            | tON(EN)     | Figure 2   |                               | 0.4   | 1.0   | 0.4                            | 1.5    | μs     |       |
| Enable Turn-Off Time                           | tOFF(EN)    | Figure 2   |                               | 0.2   | 0.7   | 0.2                            | 1.0    | μs     |       |
| Off-Isolation                                  | OIRR        | VEN = 0V, RL = 1kΩ, CL = 15pF,<br>VS = 7VRMS f = 500kHz (Note 3) |                               | 68    |       | 68                             |        | dB     |       |
| Source Off-Capacitance                         | CS(OFF)     | VS = 0V, VEN = 0V, f = 140kHz                                    |                               | 5     |       | 5                              |        | pF     |       |
| Drain Off-<br>Capacitance                      | IDG508A     | CD(OFF)  | VS = 0V, VEN = 0V, f = 140kHz |       | 25    |                                | 25     | pF     |       |
|  | DGS09A      |  |                               |       | 12    |                                | 12     |        |       |
| <b>SUPPLY</b>                                  |             |  |                               |       |       |                                |        |        |       |
| Positive Supply Current                        | I+          | VEN = 2.4V, all VA_ = 0V or 2.4V                                 |                               | 0.02  | 0.2   | 0.02                           | 0.2    | mA     |       |
| Negative Supply Current                        | I-          | VEN = 2.4V, all VA_ = 0V or 2.4V                                 |                               | -0.1  | -0.01 | -0.1                           | -0.01  | mA     |       |
| Positive Supply Current<br>in Standby          | I+          | VEN = 0V, all VA_ = 0V or 2.4V                                   |                               | 0.02  | 0.2   | 0.02                           | 0.2    | mA     |       |
| Negative Supply Current<br>in Standby          | I-          | VEN = 0V, all VA_ = 0V or 2.4V                                   |                               | -0.1  | -0.01 | -0.1                           | -0.01  | mA     |       |
| Power-Supply Range for<br>Continuous Operation | V-, V+      | (Notes 4, 5)   |                               | ±4.5  | ±18.0 | ±4.5                           | ±18.0  | V      |       |

# Monolithic CMOS Analog Multiplexers

## ELECTRICAL CHARACTERISTICS

(V<sub>+</sub> = 15V, V<sub>GND</sub> = 0V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

| PARAMETER                               | SYMBOL              | CONDITIONS  | DG508AA/M<br>DG509AA/M  |  |      | DG508AD/E/B/C<br>DG509AD/E/B/C |      |      | UNITS |
|---|---------------------|---|---|--|------|--------------------------------|------|------|-------|
|   |                     |   | MIN   | TYP  | MAX  | MIN                            | TYP  | MAX  |       |
| <b>SWITCH</b>                           |                     |   |   |  |      |                                |      |      |       |
| Analog Signal Range                     | V <sub>ANALOG</sub> |   | -15   | +15  |      | -15                            | +15  |      | V     |
| Drain-Source On-Resistance              | R <sub>DS(ON)</sub> | Sequence each switch on,<br>V <sub>A_L</sub> = 0.8V,<br>V <sub>A_H</sub> = 2.4V | V <sub>D</sub> = 10V,<br>I <sub>S</sub> = -200μA  | 500  |      | 550                            |      |      | Ω     |
|   |                     |   | V <sub>D</sub> = -10V,<br>I <sub>S</sub> = 200μA  | 500  |      | 550                            |      |      |       |
| Source Off-Leakage Current              | I <sub>S(OFF)</sub> | V <sub>EN</sub> = 0V  | V <sub>S</sub> = 10V, V <sub>D</sub> = -10V<br>V <sub>S</sub> = -10V, V <sub>D</sub> = -10V |  | +50  |                                | +50  |      | nA    |
|   |                     |   |   | -50  |      | -50                            |      |      |       |
| Drain Off-Leakage Current               | DG508A<br>DG509A    | I <sub>D(OFF)</sub>   | V <sub>EN</sub> = 0V  | V <sub>D</sub> = 10V, V <sub>S</sub> = -10V  |      | +200                           |      | +100 | nA    |
|   |                     |   |   | V <sub>D</sub> = -10V, V <sub>S</sub> = -10V | -200 |                                | -200 |      |       |
|   |                     |   |   | V <sub>D</sub> = 10V, V <sub>S</sub> = -10V  |      | +200                           |      | +100 |       |
|   |                     |   |   | V <sub>D</sub> = -10V, V <sub>S</sub> = -10V | -100 |                                | -100 |      |       |
| Drain On-Leakage Current                | DG508A<br>DG509A    | I <sub>D(ON)</sub>  | Sequence each switch on,<br>V <sub>A_L</sub> = 0.8V,<br>V <sub>A_H</sub> = 2.4V<br>(Note 2) | V <sub>S(all)</sub> = V <sub>D</sub> = 10V   |      | +200                           |      | +100 | nA    |
|   |                     |   |   | V <sub>S(all)</sub> = V <sub>D</sub> = -10V  | -200 |                                | -100 |      |       |
|   |                     |   |   | V <sub>S(all)</sub> = V <sub>D</sub> = 10V   |      | +100                           |      | +100 |       |
|   |                     |   |   | V <sub>S(all)</sub> = V <sub>D</sub> = -10V  | -100 |                                | -100 |      |       |
| <b>LOGIC INPUT</b>                      |                     |   |   |  |      |                                |      |      |       |
| Logic Input Current, Input Voltage High | I <sub>AH</sub>     | V <sub>A_</sub> = 2.4V  |   | -30  |      | -30                            |      |      | μA    |
|   |                     | V <sub>A_</sub> = 15V   |   |  | +30  |                                | +30  |      |       |
| Logic Input Current, Input Voltage Low  | I <sub>AL</sub>     | All V <sub>A_</sub> = 0V  | V <sub>EN</sub> = 2.4V  | -30  |      | -30                            |      |      | μA    |
|   |                     |   | V <sub>EN</sub> = 0V  | -30  |      | -30                            |      |      |       |

**Note 2:** I<sub>D(ON)</sub> is leakage from driver into on switch.

**Note 3:** Off-isolation = 20log  $\frac{|V_S|}{|V_D|}$

V<sub>S</sub> = input to off switch,  
V<sub>D</sub> = output due to V<sub>S</sub>.

**Note 4:** Electrical characteristics (such as on-resistance) change when power supplies other than ±15V are used.

**Note 5:** For designs requiring single 5V or dual ±5V operation, refer to Maxim's improved MAX338 and MAX339. Minimum operating voltage for DG508ADY/MY and DG509ADY/MY is ±9V.

# Monolithic CMOS Analog Multiplexers

**DG508A/DG509A**

## Pin Configurations



## Pin Descriptions

| PIN              |                  | NAME       | FUNCTION                      |
|------------------|------------------|------------|-------------------------------|
| DG508A<br>DIP/SO | DG509A<br>DIP/SO |            |                               |
| 1, 15, 16        | —                | A0, A2, A1 | Address Input                 |
| —                | 1, 16            | A0, A1     | Address Input                 |
| 2                | 2                | EN         | Enable                        |
| 3                | 3                | V-         | Negative-Supply Voltage Input |
| 4-7              | —                | S1-S4      | Analog Inputs, Bidirectional  |
| —                | 4-7              | S1A-S4A    | Analog Inputs, Bidirectional  |
| 8                | —                | D          | Analog Outputs, Bidirectional |
| —                | 8, 9             | DA, DB     | Analog Outputs, Bidirectional |
| 9-12             | —                | S8-S5      | Analog Inputs, Bidirectional  |
| —                | 10-13            | S4B-S1B    | Analog Inputs, Bidirectional  |
| 13               | 14               | V+         | Positive-Supply Voltage Input |
| 14               | 15               | GND        | Ground                        |

## Functional Diagrams



# Monolithic CMOS Analog Multiplexers

**DG508A/DG509A**



Figure 1a. Switching-Time Test Circuit



Figure 1b. Switching-Time Test Circuit



Figure 2a. DG508A Enable-Time Test Circuit



Figure 2b. DG509A Enable-Time Test Circuit

# Monolithic CMOS Analog Multiplexers

**DG508A/DG509A**

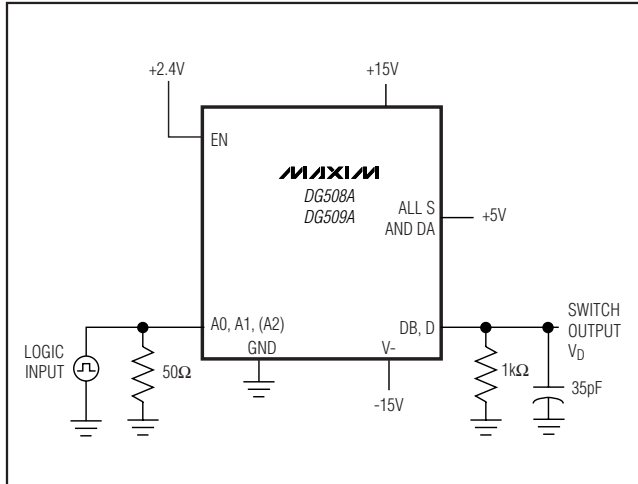


Figure 3. Break-Before-Make Test Circuit



Figure 4. Timing Diagram for Figures 1, 2, and 3

**Table 1a. DG508A Truth Table**

| A2 | A1 | A0 | EN | ON SWITCH |
|----|----|----|----|-----------|
| X  | X  | X  | 0  | NONE      |
| 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 = Don't care.

**Table 1b. DG509A Truth Table**

| A1 | A0 | EN | ON SWITCH |
|----|----|----|-----------|
| X  | X  | 0  | NONE      |
| 0  | 0  | 1  | 1         |
| 0  | 1  | 1  | 2         |
| 1  | 0  | 1  | 3         |
| 1  | 1  | 1  | 4         |

X = Don't care.

# Monolithic CMOS Analog Multiplexers

## Typical Operating Circuits (continued)



## Package Information

For the latest package outline information and land patterns, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE   | PACKAGE CODE | DOCUMENT NO.            |
|----------------|--------------|-------------------------|
| 16 Plastic DIP | P16-1        | <a href="#">21-0043</a> |
| 16 Wide SO     | W16-2        | <a href="#">21-0042</a> |
| 16 Narrow SO   | S16-5        | <a href="#">21-0041</a> |
| 16 CERDIP      | J16-3        | <a href="#">21-0045</a> |



# Monolithic CMOS Analog Multiplexers

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION   | PAGES CHANGED |
|-----------------|---------------|---|---------------|
| 4               | 5/10          | Updated the "Drain-Source On-Resistance" parameter for both the $T_A = +25^\circ\text{C}$ and $T_A = T_{\text{MIN}}$ to $T_{\text{MAX}}$ conditions.  | 2, 4          |
|                 |               | Deleted the QFN package from the <i>Ordering Information</i> , <i>Absolute Maximum Ratings</i> , <i>Pin Configurations</i> , <i>Pin Descriptions</i> , and <i>Package Information</i> sections. | 1, 2, 5, 8    |
|                 |               | Added the DG508AMY/PR and DG509AMY/PR parts to the <i>Ordering Information</i> table.   | 1             |

DG508A/DG509A

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