

### FEATURES

- ±2 V to ±6 V dual supply
- 2 V to 12 V single supply
- Automotive temperature range –40°C to +125°C
- <0.1 nA leakage currents
- 45 Ω on resistance over full signal range
- Rail-to-rail switching operation
- Single 8-to-1 multiplexer ADG658
- Differential 4-to-1 multiplexer ADG659
- 16-lead LFCSP/TSSOP/QSOP packages
- Typical power consumption <0.1 μW
- TTL/CMOS compatible inputs
- Package upgrades to 74HC4051/74HC4052 and  
MAX4051/MAX4052/MAX4581/MAX4582

### APPLICATIONS

- Automotive applications
- Automatic test equipment
- Data acquisition systems
- Battery-powered systems
- Communication systems
- Audio and video signal routing
- Relay replacement
- Sample-and-hold systems
- Industrial control systems

### GENERAL DESCRIPTION

The ADG658 and ADG659 are low voltage, CMOS analog multiplexers comprised of eight single channels and four differential channels, respectively. The ADG658 switches one of eight inputs (S1–S8) to a common output, D, as determined by the 3-bit binary address lines A0, A1, and A2. The ADG659 switches one of four differential inputs to a common differential output, as determined by the 2-bit binary address lines A0 and A1. An  $\overline{\text{EN}}$  input on both devices is used to enable or disable the device. When disabled, all channels are switched off.

These parts are designed on an enhanced process that provides lower power dissipation yet gives high switching speeds. These parts can operate equally well as either multiplexers or demultiplexers and have an input range that extends to the supplies. All channels exhibit break-before-make switching action, preventing momentary shorting when switching channels. All digital inputs have 0.8 V to 2.4 V logic thresholds, ensuring TTL/CMOS logic compatibility when using single +5 V or dual ±5 V supplies.

### FUNCTIONAL BLOCK DIAGRAM

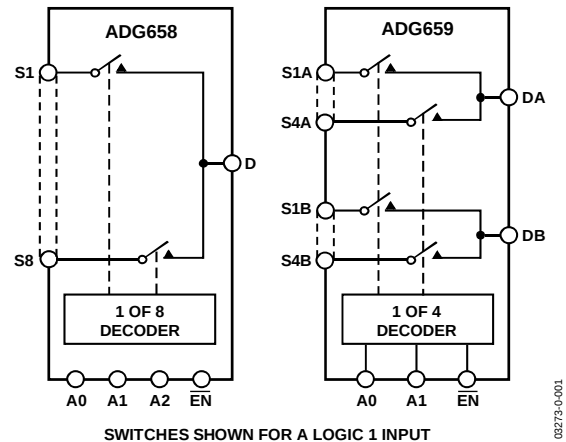


Figure 1.

The ADG658 and ADG659 are available in 16-lead TSSOP/QSOP packages and 16-lead 4 mm × 4 mm LFCSP packages.

### PRODUCT HIGHLIGHTS

1. Single- and dual-supply operation. The ADG658 and ADG659 offer high performance and are fully specified and guaranteed with ±5 V, +5 V, and +3 V supply rails.
2. Automotive temperature range –40°C to +125°C.
3. Low power consumption, typically <0.1 μW.
4. 16-lead 4 mm × 4 mm LFCSP packages, 16-lead TSSOP package and 16-lead QSOP package.

#### Rev. B

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REVISION HISTORY

|                                     |           |
|-------------------------------------|-----------|
| <b>2/09—Rev. A to Rev. B</b>        |           |
| Changes to Ordering Guide .....     | 20        |
| <b>7/04—Rev. 0 to Rev. A</b>        |           |
| Updated Format.....                 | Universal |
| Added QSOP Package Outline .....    | 20        |
| Changes to Ordering Guide .....     | 20        |
| <b>3/03—Rev. 0: Initial Version</b> |           |

# SPECIFICATIONS

## DUAL SUPPLY

$V_{DD} = +5\text{ V} \pm 10\%$ ,  $V_{SS} = -5\text{ V} \pm 10\%$ , GND = 0 V, unless otherwise noted.

Table 1.

| Parameter                                                | +25°C       | B Version<br>–40°C<br>to +85°C | Y Version<br>–40°C<br>to +125°C | Unit              | Test Conditions/Comments                                                      |
|----------------------------------------------------------|-------------|--------------------------------|---------------------------------|-------------------|-------------------------------------------------------------------------------|
| <b>ANALOG SWITCH</b>                                     |             |                                |                                 |                   |                                                                               |
| Analog Signal Range                                      |             |                                | $V_{SS}$ to $V_{DD}$            | V                 | $V_{DD} = +4.5\text{ V}$ , $V_{SS} = -4.5\text{ V}$                           |
| On Resistance ( $R_{ON}$ )                               | 45          |                                |                                 | $\Omega$ typ      | $V_S = \pm 4.5\text{ V}$ , $I_S = 1\text{ mA}$ ; see Figure 21                |
|                                                          | 75          | 90                             | 100                             | $\Omega$ max      |                                                                               |
| On Resistance Match between Channels ( $\Delta R_{ON}$ ) | 1.3         |                                |                                 | $\Omega$ typ      | $V_S = 3.5\text{ V}$ , $I_S = 1\text{ mA}$                                    |
|                                                          | 3           | 3.2                            | 3.5                             | $\Omega$ max      | $V_{DD} = +5\text{ V}$ , $V_{SS} = -5\text{ V}$ ;                             |
| On Resistance Flatness ( $R_{FLAT(ON)}$ )                | 10          |                                |                                 | $\Omega$ typ      | $V_S = \pm 3\text{ V}$ , $I_S = 1\text{ mA}$                                  |
|                                                          | 16          | 17                             | 18                              | $\Omega$ max      |                                                                               |
| <b>LEAKAGE CURRENTS</b>                                  |             |                                |                                 |                   |                                                                               |
| Source OFF Leakage $I_S$ (OFF)                           | $\pm 0.005$ |                                |                                 | nA typ            | $V_{DD} = +5.5\text{ V}$ , $V_{SS} = -5.5\text{ V}$                           |
|                                                          | $\pm 0.2$   |                                | $\pm 5$                         | nA max            | $V_D = \pm 4.5\text{ V}$ , $V_S = \mp 4.5\text{ V}$ ; see Figure 22           |
| Drain OFF Leakage $I_D$ (OFF)                            | $\pm 0.005$ |                                |                                 | nA typ            | $V_D = \pm 4.5\text{ V}$ , $V_S = \mp 4.5\text{ V}$ ; see Figure 23           |
| ADG658                                                   | $\pm 0.2$   |                                | $\pm 5$                         | nA max            |                                                                               |
| ADG659                                                   | $\pm 0.1$   |                                | $\pm 2.5$                       | nA max            |                                                                               |
| Channel ON Leakage $I_D$ , $I_S$ (ON)                    | $\pm 0.005$ |                                |                                 | nA typ            | $V_D = V_S = \pm 4.5\text{ V}$ ; see Figure 24                                |
| ADG658                                                   | $\pm 0.2$   |                                | $\pm 5$                         | nA max            |                                                                               |
| ADG659                                                   | $\pm 0.1$   |                                | $\pm 2.5$                       | nA max            |                                                                               |
| <b>DIGITAL INPUTS</b>                                    |             |                                |                                 |                   |                                                                               |
| Input High Voltage, $V_{INH}$                            |             |                                | 2.4                             | V min             |                                                                               |
| Input Low Voltage, $V_{INL}$                             |             |                                | 0.8                             | V max             |                                                                               |
| Input Current                                            |             |                                |                                 |                   |                                                                               |
| $I_{INL}$ or $I_{INH}$                                   | 0.005       |                                |                                 | $\mu\text{A}$ typ | $V_{IN} = V_{INL}$ or $V_{INH}$                                               |
|                                                          |             |                                | $\pm 1$                         | $\mu\text{A}$ max |                                                                               |
| $C_{IN}$ , Digital Input Capacitance                     | 2           |                                |                                 | pF typ            |                                                                               |
| <b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>               |             |                                |                                 |                   |                                                                               |
| $t_{TRANSITION}$                                         | 80          |                                |                                 | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                    |
|                                                          | 115         | 140                            | 165                             | ns max            | $V_S = 3\text{ V}$ ; see Figure 25                                            |
| $t_{ON}(\overline{EN})$                                  | 80          |                                |                                 | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                    |
|                                                          | 115         | 140                            | 165                             | ns max            | $V_S = 3\text{ V}$ ; see Figure 27                                            |
| $t_{OFF}(\overline{EN})$                                 | 30          |                                |                                 | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                    |
|                                                          | 45          | 50                             | 55                              | ns max            | $V_S = 3\text{ V}$ ; see Figure 27                                            |
| Break-Before-Make Time Delay, $t_{BBM}$                  | 50          |                                |                                 | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                    |
|                                                          |             |                                | 10                              | ns min            | $V_{S1} = V_{S2} = 3\text{ V}$ ; see Figure 26                                |
| Charge Injection                                         | 2           |                                |                                 | pC typ            | $V_S = 0\text{ V}$ , $R_S = 0\ \Omega$ ,                                      |
|                                                          | 4           |                                |                                 | pC max            | $C_L = 1\text{ nF}$ ; see Figure 28                                           |
| Off Isolation                                            | –90         |                                |                                 | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 29 |
| Total Harmonic Distortion, THD + N                       | 0.025       |                                |                                 | % typ             | $R_L = 600\ \Omega$ , 2 V p-p, $f = 20\text{ Hz}$ to 20 kHz                   |
| Channel-to-Channel Crosstalk (ADG659)                    | –90         |                                |                                 | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 31 |
| –3 dB Bandwidth                                          |             |                                |                                 |                   |                                                                               |
| ADG658                                                   | 210         |                                |                                 | MHz typ           | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 30                      |
| ADG659                                                   | 400         |                                |                                 | MHz typ           |                                                                               |

# ADG658/ADG659

| Parameter                            | +25°C | B Version<br>–40°C<br>to +85°C | Y Version<br>–40°C<br>to +125°C | Unit             | Test Conditions/Comments                           |
|--------------------------------------|-------|--------------------------------|---------------------------------|------------------|----------------------------------------------------|
| C <sub>S</sub> (OFF)                 | 4     |                                |                                 | pF typ           | f = 1 MHz                                          |
| C <sub>D</sub> (OFF)                 |       |                                |                                 |                  |                                                    |
| ADG658                               | 23    |                                |                                 | pF typ           | f = 1 MHz                                          |
| ADG659                               | 12    |                                |                                 | pF typ           | f = 1 MHz                                          |
| C <sub>D</sub> , C <sub>S</sub> (ON) |       |                                |                                 |                  |                                                    |
| ADG658                               | 28    |                                |                                 | pF typ           | f = 1 MHz                                          |
| ADG659                               | 16    |                                |                                 | pF typ           | f = 1 MHz                                          |
| POWER REQUIREMENTS                   |       |                                |                                 |                  | V <sub>DD</sub> = +5.5 V, V <sub>SS</sub> = –5.5 V |
| I <sub>DD</sub>                      | 0.01  |                                | 1                               | μA typ<br>μA max | Digital Inputs = 0 V or 5.5 V                      |
| I <sub>SS</sub>                      | 0.01  |                                | 1                               | μA typ<br>μA max | Digital Inputs = 0 V or 5.5 V                      |

<sup>1</sup> Guaranteed by design; not subject to production test.

**5 V SINGLE SUPPLY**

$V_{DD} = 5\text{ V} \pm 10\%$ ,  $V_{SS} = 0\text{ V}$ ,  $GND = 0\text{ V}$ , unless otherwise noted.

**Table 2.**

| Parameter                                                | +25°C       | B Version<br>–40°C<br>to +85°C | Y Version<br>–40°C<br>to +125°C | Unit              | Test Conditions/Comments                                                                                   |
|----------------------------------------------------------|-------------|--------------------------------|---------------------------------|-------------------|------------------------------------------------------------------------------------------------------------|
| <b>ANALOG SWITCH</b>                                     |             |                                |                                 |                   |                                                                                                            |
| Analog Signal Range                                      |             |                                | 0 to $V_{DD}$                   | V                 | $V_{DD} = 4.5\text{ V}$ , $V_{SS} = 0\text{ V}$                                                            |
| On Resistance ( $R_{ON}$ )                               | 85          |                                |                                 | $\Omega$ typ      | $V_S = 0\text{ V}$ to $4.5\text{ V}$ , $I_S = 1\text{ mA}$ ; see Figure 21                                 |
|                                                          | 150         | 160                            | 200                             | $\Omega$ max      |                                                                                                            |
| On Resistance Match between Channels ( $\Delta R_{ON}$ ) | 4.5         |                                |                                 | $\Omega$ typ      | $V_S = 3.5\text{ V}$ , $I_S = 1\text{ mA}$                                                                 |
|                                                          | 8           | 9                              | 10                              | $\Omega$ max      |                                                                                                            |
| On Resistance Flatness ( $R_{FLAT(ON)}$ )                | 13          | 14                             | 16                              | $\Omega$ typ      | $V_{DD} = 5\text{ V}$ , $V_{SS} = 0\text{ V}$ , $V_S = 1.5\text{ V}$ to $4\text{ V}$ , $I_S = 1\text{ mA}$ |
| <b>LEAKAGE CURRENTS</b>                                  |             |                                |                                 |                   |                                                                                                            |
| Source OFF Leakage $I_S$ (OFF)                           | $\pm 0.005$ |                                |                                 | nA typ            | $V_{DD} = 5.5\text{ V}$                                                                                    |
|                                                          | $\pm 0.2$   |                                | $\pm 5$                         | nA max            | $V_S = 1\text{ V}/4.5\text{ V}$ , $V_D = 4.5\text{ V}/1\text{ V}$ ; see Figure 22                          |
| Drain OFF Leakage $I_D$ (OFF)                            | $\pm 0.005$ |                                |                                 | nA typ            | $V_S = 1\text{ V}/4.5\text{ V}$ , $V_D = 4.5\text{ V}/1\text{ V}$ ; see Figure 23                          |
| ADG658                                                   | $\pm 0.2$   |                                | $\pm 5$                         | nA max            |                                                                                                            |
| ADG659                                                   | $\pm 0.1$   |                                | $\pm 2.5$                       | nA max            |                                                                                                            |
| Channel ON Leakage $I_D$ , $I_S$ (ON)                    | $\pm 0.005$ |                                |                                 | nA typ            | $V_S = V_D = 1\text{ V}$ or $4.5\text{ V}$ , see Figure 24                                                 |
| ADG658                                                   | $\pm 0.2$   |                                | $\pm 5$                         | nA max            |                                                                                                            |
| ADG659                                                   | $\pm 0.1$   |                                | $\pm 2.5$                       | nA max            |                                                                                                            |
| <b>DIGITAL INPUTS</b>                                    |             |                                |                                 |                   |                                                                                                            |
| Input High Voltage, $V_{INH}$                            |             |                                | 2.4                             | V min             |                                                                                                            |
| Input Low Voltage, $V_{INL}$                             |             |                                | 0.8                             | V max             |                                                                                                            |
| Input Current<br>$I_{INL}$ or $I_{INH}$                  | 0.005       |                                |                                 | $\mu\text{A}$ typ | $V_{IN} = V_{INL}$ or $V_{INH}$                                                                            |
|                                                          |             |                                | $\pm 1$                         | $\mu\text{A}$ max |                                                                                                            |
| $C_{IN}$ , Digital Input Capacitance                     | 2           |                                |                                 | pF typ            |                                                                                                            |
| <b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>               |             |                                |                                 |                   |                                                                                                            |
| $t_{TRANSITION}$                                         | 120         |                                |                                 | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                 |
|                                                          | 200         | 270                            | 300                             | ns max            | $V_S = 3\text{ V}$ ; see Figure 25                                                                         |
| $t_{ON}(\overline{EN})$                                  | 120         |                                |                                 | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                 |
|                                                          | 190         | 245                            | 280                             | ns max            | $V_S = 3\text{ V}$ ; see Figure 27                                                                         |
| $t_{OFF}(\overline{EN})$                                 | 35          |                                |                                 | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                 |
|                                                          | 50          | 60                             | 70                              | ns max            | $V_S = 3\text{ V}$ ; see Figure 27                                                                         |
| Break-Before-Make Time Delay, $t_{BBM}$                  | 100         |                                |                                 | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                 |
|                                                          |             |                                | 10                              | ns min            | $V_{S1} = V_{S2} = 3\text{ V}$ ; see Figure 26                                                             |
| Charge Injection                                         | 0.5         |                                |                                 | pC typ            | $V_S = 2.5\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; see Figure 28                             |
|                                                          | 1           |                                |                                 | pC max            |                                                                                                            |
| Off Isolation                                            | –90         |                                |                                 | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 29                              |
| Channel-to-Channel Crosstalk<br>(ADG659)                 | –90         |                                |                                 | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; $f = 1\text{ MHz}$ ; see Figure 31                              |
| –3 dB Bandwidth                                          |             |                                |                                 |                   |                                                                                                            |
| ADG658                                                   | 180         |                                |                                 | MHz typ           | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 30                                                   |
| ADG659                                                   | 330         |                                |                                 | MHz typ           |                                                                                                            |
| $C_S$ (OFF)                                              | 5           |                                |                                 | pF typ            | $f = 1\text{ MHz}$                                                                                         |
| $C_D$ (OFF)                                              |             |                                |                                 |                   |                                                                                                            |
| ADG658                                                   | 29          |                                |                                 | pF typ            | $f = 1\text{ MHz}$                                                                                         |
| ADG659                                                   | 15          |                                |                                 | pF typ            | $f = 1\text{ MHz}$                                                                                         |

# ADG658/ADG659

| Parameter                            | +25°C | B Version<br>–40°C<br>to +85°C | Y Version<br>–40°C<br>to +125°C | Unit             | Test Conditions/Comments      |
|--------------------------------------|-------|--------------------------------|---------------------------------|------------------|-------------------------------|
| C <sub>D</sub> , C <sub>S</sub> (ON) |       |                                |                                 |                  |                               |
| ADG658                               | 30    |                                |                                 | pF typ           | f = 1 MHz                     |
| ADG659                               | 16    |                                |                                 | pF typ           | f = 1 MHz                     |
| POWER REQUIREMENTS                   |       |                                |                                 |                  | V <sub>DD</sub> = 5.5 V       |
| I <sub>DD</sub>                      | 0.01  |                                | 1                               | μA typ<br>μA max | Digital Inputs = 0 V or 5.5 V |

<sup>1</sup> Guaranteed by design; not subject to production test.

**2.7 V TO 3.6 V SINGLE SUPPLY**

$V_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = 0$  V, GND = 0 V, unless otherwise noted.

**Table 3.**

| Parameter                                  | +25°C       | B Version<br>–40°C<br>to +85°C | Y Version<br>–40°C<br>to +125°C | Unit         | Test Conditions/Comments                                        |
|--------------------------------------------|-------------|--------------------------------|---------------------------------|--------------|-----------------------------------------------------------------|
| <b>ANALOG SWITCH</b>                       |             |                                |                                 |              |                                                                 |
| Analog Signal Range                        |             |                                | 0 to $V_{DD}$                   | V            | $V_{DD} = 2.7$ V, $V_{SS} = 0$ V                                |
| On Resistance ( $R_{ON}$ )                 | 185         |                                |                                 | $\Omega$ typ | $V_S = 0$ V to $2.7$ V, $I_S = 0.1$ mA; see Figure 21           |
|                                            | 300         | 350                            | 400                             | $\Omega$ max |                                                                 |
| On Resistance Match between                | 2           |                                |                                 | $\Omega$ typ | $V_S = 1.5$ V, $I_S = 0.1$ mA                                   |
| Channels ( $\Delta R_{ON}$ )               | 4.5         | 6                              | 7                               | $\Omega$ max |                                                                 |
| <b>LEAKAGE CURRENTS</b>                    |             |                                |                                 |              |                                                                 |
| Source OFF Leakage $I_S$ (OFF)             | $\pm 0.005$ |                                |                                 | nA typ       | $V_{DD} = 3.3$ V                                                |
|                                            | $\pm 0.2$   |                                | $\pm 5$                         | nA max       | $V_S = 1$ V/3 V, $V_D = 3$ V/1 V; see Figure 22                 |
| Drain OFF Leakage $I_D$ (OFF)              | $\pm 0.005$ |                                |                                 | nA typ       | $V_S = 1$ V/3 V, $V_D = 3$ V/1 V; see Figure 23                 |
| ADG658                                     | $\pm 0.2$   |                                | $\pm 5$                         | nA max       |                                                                 |
| ADG659                                     | $\pm 0.1$   |                                | $\pm 2.5$                       | nA max       |                                                                 |
| Channel ON Leakage $I_D, I_S$ (ON)         | $\pm 0.005$ |                                |                                 | nA typ       | $V_S = V_D = 1$ V or 3 V, see Figure 24                         |
| ADG658                                     | $\pm 0.2$   |                                | $\pm 5$                         | nA max       |                                                                 |
| ADG659                                     | $\pm 0.1$   |                                | $\pm 2.5$                       | nA max       |                                                                 |
| <b>DIGITAL INPUTS</b>                      |             |                                |                                 |              |                                                                 |
| Input High Voltage, $V_{INH}$              |             |                                | 2.0                             | V min        |                                                                 |
| Input Low Voltage, $V_{INL}$               |             |                                | 0.5                             | V max        |                                                                 |
| Input Current                              |             |                                |                                 |              |                                                                 |
| $I_{INL}$ or $I_{INH}$                     | 0.005       |                                |                                 | $\mu$ A typ  | $V_{IN} = V_{INL}$ or $V_{INH}$                                 |
|                                            |             |                                | $\pm 1$                         | $\mu$ A max  |                                                                 |
| $C_{IN}$ , Digital Input Capacitance       | 2           |                                |                                 | pF typ       |                                                                 |
| <b>DYNAMIC CHARACTERISTICS<sup>1</sup></b> |             |                                |                                 |              |                                                                 |
| $t_{TRANSITION}$                           | 200         |                                |                                 | ns typ       | $R_L = 300$ $\Omega$ , $C_L = 35$ pF                            |
|                                            | 370         | 440                            | 490                             | ns max       | $V_S = 1.5$ V; see Figure 25                                    |
| $t_{ON}(\overline{EN})$                    | 230         |                                |                                 | ns typ       | $R_L = 300$ $\Omega$ , $C_L = 35$ pF                            |
|                                            | 370         | 440                            | 490                             | ns max       | $V_S = 1.5$ V; see Figure 27                                    |
| $t_{OFF}(\overline{EN})$                   | 50          |                                |                                 | ns typ       | $R_L = 300$ $\Omega$ , $C_L = 35$ pF                            |
|                                            | 80          | 90                             | 110                             | ns max       | $V_S = 1.5$ V; see Figure 27                                    |
| Break-Before-Make Time Delay, $t_{BBM}$    | 200         |                                |                                 | ns typ       | $R_L = 300$ $\Omega$ , $C_L = 35$ pF                            |
|                                            |             |                                | 10                              | ns min       | $V_{S1} = V_{S2} = 1.5$ V; see Figure 26                        |
| Charge Injection                           | 1           |                                |                                 | pC typ       | $V_S = 1.5$ V, $R_S = 0$ $\Omega$ , $C_L = 1$ nF; see Figure 28 |
|                                            | 2           |                                |                                 | pC max       |                                                                 |
| Off Isolation                              | –90         |                                |                                 | dB typ       | $R_L = 50$ $\Omega$ , $C_L = 5$ pF, $f = 1$ MHz; see Figure 29  |
| Channel-to-Channel Crosstalk<br>(ADG659)   | –90         |                                |                                 | dB typ       | $R_L = 50$ $\Omega$ , $C_L = 5$ pF; $f = 1$ MHz; see Figure 31  |
| –3 dB Bandwidth                            |             |                                |                                 |              |                                                                 |
| ADG658                                     | 160         |                                |                                 | MHz typ      | $R_L = 50$ $\Omega$ , $C_L = 5$ pF; see Figure 30               |
| ADG659                                     | 300         |                                |                                 | MHz typ      |                                                                 |
| $C_S$ (OFF)                                | 5           |                                |                                 | pF typ       | $f = 1$ MHz                                                     |
| $C_D$ (OFF)                                |             |                                |                                 |              |                                                                 |
| ADG658                                     | 29          |                                |                                 | pF typ       | $f = 1$ MHz                                                     |
| ADG659                                     | 15          |                                |                                 | pF typ       | $f = 1$ MHz                                                     |

# ADG658/ADG659

| Parameter                            | B Version |                   | Y Version          | Unit             | Test Conditions/Comments      |
|--------------------------------------|-----------|-------------------|--------------------|------------------|-------------------------------|
|                                      | +25°C     | –40°C<br>to +85°C | –40°C<br>to +125°C |                  |                               |
| C <sub>D</sub> , C <sub>S</sub> (ON) |           |                   |                    |                  |                               |
| ADG658                               | 30        |                   |                    | pF typ           | f = 1 MHz                     |
| ADG659                               | 16        |                   |                    | pF typ           | f = 1 MHz                     |
| POWER REQUIREMENTS                   |           |                   |                    |                  | V <sub>DD</sub> = 3.6 V       |
| I <sub>DD</sub>                      | 0.01      |                   | 1                  | μA typ<br>μA max | Digital Inputs = 0 V or 3.6 V |

<sup>1</sup> Guaranteed by design; not subject to production test.

## ABSOLUTE MAXIMUM RATINGS

$T_A = 25^\circ\text{C}$ , unless otherwise noted.

**Table 4.**

| Parameter                                                    | Rating                                                                      |
|--------------------------------------------------------------|-----------------------------------------------------------------------------|
| $V_{DD}$ to $V_{SS}$                                         | 13 V                                                                        |
| $V_{DD}$ to GND                                              | −0.3 V to +13 V                                                             |
| $V_{SS}$ to GND                                              | +0.3 V to −6.5 V                                                            |
| Analog Inputs <sup>1</sup>                                   | $V_{SS} - 0.3 \text{ V}$ to $V_{DD} + 0.3 \text{ V}$                        |
| Digital Inputs <sup>1</sup>                                  | GND − 0.3 V to $V_{DD} + 0.3 \text{ V}$<br>or 10 mA, whichever occurs first |
| Peak Current, S or D<br>(Pulsed at 1 ms, 10% duty cycle max) | 40 mA                                                                       |
| Continuous Current, S or D                                   | 20 mA                                                                       |
| Operating Temperature Range                                  |                                                                             |
| Automotive (Y Version)                                       | −40°C to +125°C                                                             |
| Industrial (B Version)                                       | −40°C to +85°C                                                              |
| Storage Temperature Range                                    | −65°C to +150°C                                                             |
| Junction Temperature                                         | 150°C                                                                       |
| $\theta_{JA}$ Thermal Impedance                              |                                                                             |
| 16-Lead QSOP                                                 | 104°C/W                                                                     |
| 16-Lead TSSOP                                                | 150.4°C/W                                                                   |
| 16-Lead LFCSP (4-Layer Board)                                | 70°C/W                                                                      |
| Lead Temperature, Soldering                                  |                                                                             |
| Vapor Phase (60 sec)                                         | 215°C                                                                       |
| Infrared (15 sec)                                            | 220°C                                                                       |
| ESD                                                          | 5.5 kV                                                                      |

<sup>1</sup> Over voltages at  $A_x$ ,  $\overline{EN}$ , S, or D are clamped by internal diodes. Current should be limited to the maximum ratings.

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### ESD CAUTION



#### ESD (electrostatic discharge) sensitive device.

Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

# ADG658/ADG659

Table 5. ADG658 Truth Table

| A2             | A1             | A0             | $\overline{\text{EN}}$ | Switch Condition |
|----------------|----------------|----------------|------------------------|------------------|
| X <sup>1</sup> | X <sup>1</sup> | X <sup>1</sup> | 1                      | None             |
| 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                |

<sup>1</sup> X = Don't Care

Table 6. ADG659 Truth Table

| A1             | A0             | $\overline{\text{EN}}$ | On Switch Pair |
|----------------|----------------|------------------------|----------------|
| X <sup>1</sup> | X <sup>1</sup> | 1                      | None           |
| 0              | 0              | 0                      | 1              |
| 0              | 1              | 0                      | 2              |
| 1              | 0              | 0                      | 3              |
| 1              | 1              | 0                      | 4              |

<sup>1</sup> X = Don't Care

## PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

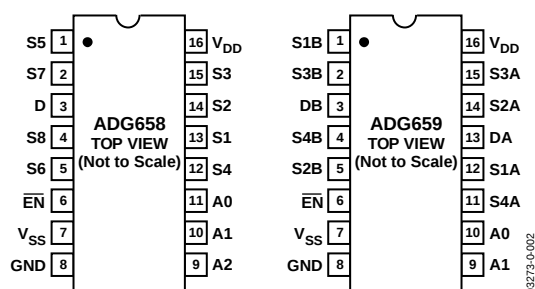


Figure 2. 16-Lead TSSOP/QSOP Pin Configuration

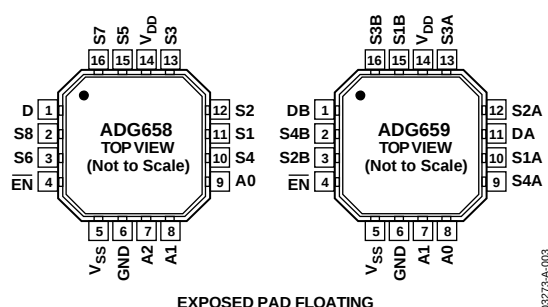


Figure 3. 16-Lead, 4 mm x 4 mm LFCSP Pin Configuration

Table 7. Pin Function Descriptions

| Parameter               | Description                                                                                                                                      |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| $V_{DD}$                | Most Positive Power Supply Potential.                                                                                                            |
| $V_{SS}$                | Most Negative Power Supply Potential.                                                                                                            |
| $I_{DD}$                | Positive Supply Current.                                                                                                                         |
| $I_{SS}$                | Negative Supply Current.                                                                                                                         |
| GND                     | Ground (0 V) Reference.                                                                                                                          |
| S                       | Source Terminal. May be an input or output.                                                                                                      |
| D                       | Drain Terminal. May be an input or output.                                                                                                       |
| $A_X$                   | Logic Control Input.                                                                                                                             |
| EN                      | Active Low Digital Input. When high, device is disabled and all switches are OFF. When low, $A_X$ logic inputs determine ON switch.              |
| $V_D$ ( $V_S$ )         | Analog Voltage on Terminals D, S.                                                                                                                |
| $R_{ON}$                | Ohmic Resistance between D and S.                                                                                                                |
| $\Delta R_{ON}$         | On Resistance Match between Any Two Channels, i.e., $R_{ONmax} - R_{ONmin}$ .                                                                    |
| $R_{FLAT(ON)}$          | Flatness is defined as the difference between the maximum and minimum value of ON Resistance as measured over the specified analog signal range. |
| $I_S$ (OFF)             | Source Leakage Current with the Switch OFF.                                                                                                      |
| $I_D$ (OFF)             | Drain Leakage Current with the Switch OFF.                                                                                                       |
| $I_D, I_S$ (ON)         | Channel Leakage Current with the Switch ON.                                                                                                      |
| $V_{INL}$               | Maximum Input Voltage for Logic 0.                                                                                                               |
| $V_{INH}$               | Minimum Input Voltage for Logic 1.                                                                                                               |
| $I_{INL}$ ( $I_{INH}$ ) | Input Current of the Digital Input.                                                                                                              |
| $C_S$ (OFF)             | OFF Switch Source Capacitance. Measured with reference to ground.                                                                                |
| $C_D$ (OFF)             | OFF Switch Drain Capacitance. Measured with reference to ground.                                                                                 |
| $C_D, C_S$ (ON)         | ON Switch Capacitance. Measured with reference to ground.                                                                                        |
| $C_{IN}$                | Digital Input Capacitance.                                                                                                                       |

## ADG658/ADG659

| Parameter        | Description                                                                                                  |
|------------------|--------------------------------------------------------------------------------------------------------------|
| t <sub>ON</sub>  | Delay between Applying the Digital Control Input and the Output Switching ON. See Test Circuit 7.            |
| t <sub>OFF</sub> | Delay between Applying the Digital Control Input and the Output Switching OFF.                               |
| t <sub>BBM</sub> | ON Time. Measured between 80% points of both switches when switching from one address state to another.      |
| Charge Injection | Measure of the Glitch Impulse Transferred from the Digital Input to the Analog Output during Switching.      |
| Off Isolation    | Measure of Unwanted Signal Coupling through an OFF Switch.                                                   |
| Crosstalk        | Measure of Unwanted Signal Coupled through from One Channel to Another as a Result of Parasitic Capacitance. |
| Bandwidth        | The Frequency at which the Output is Attenuated by 3 dB.                                                     |
| On Response      | The Frequency Response of the ON Switch.                                                                     |
| Insertion Loss   | The Loss Due to the ON Resistance of the Switch.                                                             |

# TYPICAL PERFORMANCE CHARACTERISTICS

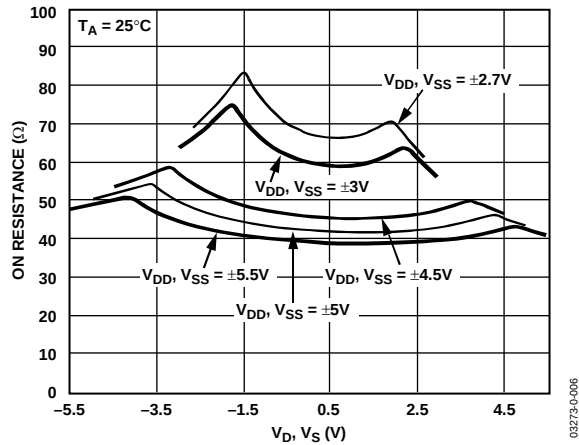


Figure 4. On Resistance vs.  $V_D$  ( $V_S$ ) for Dual Supply

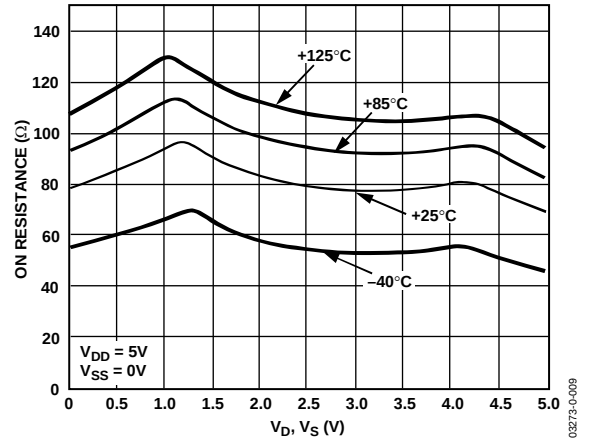


Figure 7. On Resistance vs.  $V_D$  ( $V_S$ ) for Different Temperatures (Single Supply)

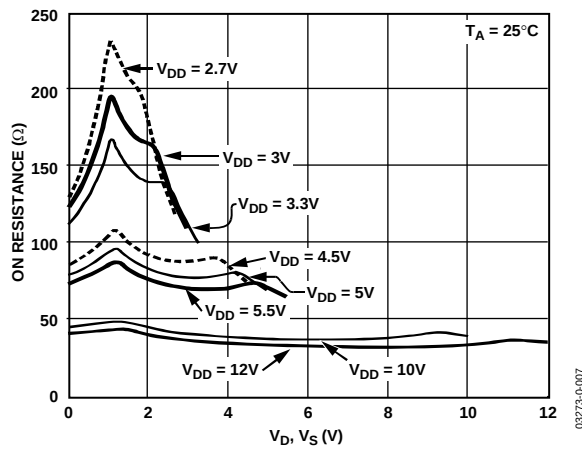


Figure 5. On Resistance vs.  $V_D$  ( $V_S$ ) for Single Supply

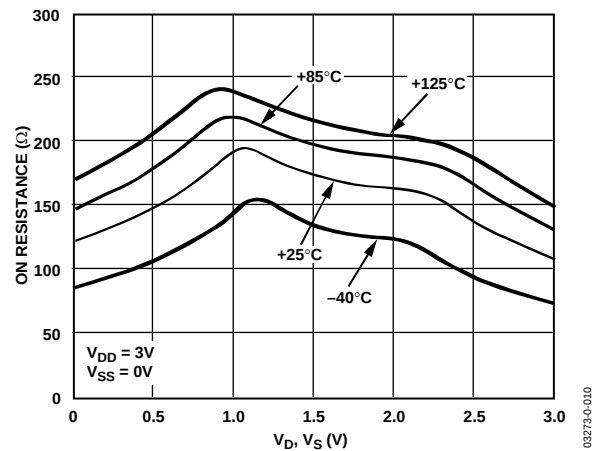


Figure 8. On Resistance vs.  $V_D$  ( $V_S$ ) for Different Temperatures (Single Supply)

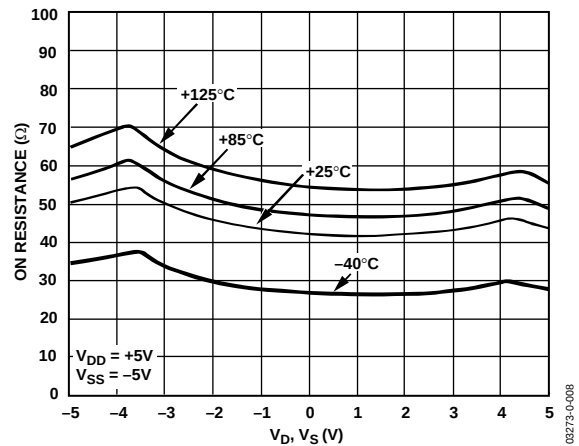


Figure 6. On Resistance vs.  $V_D$  ( $V_S$ ) for Different Temperatures (Dual Supply)

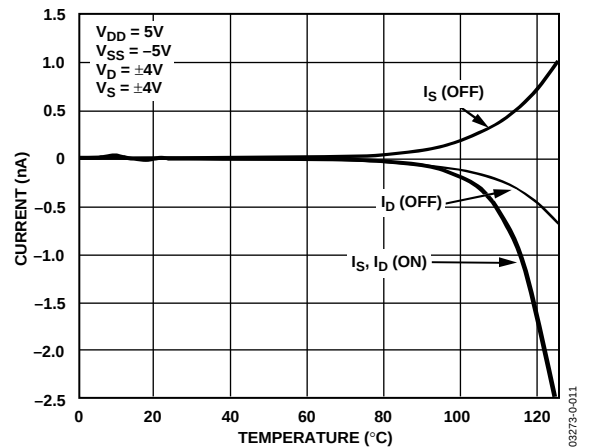


Figure 9. Leakage Current vs. Temperature (Dual Supply)

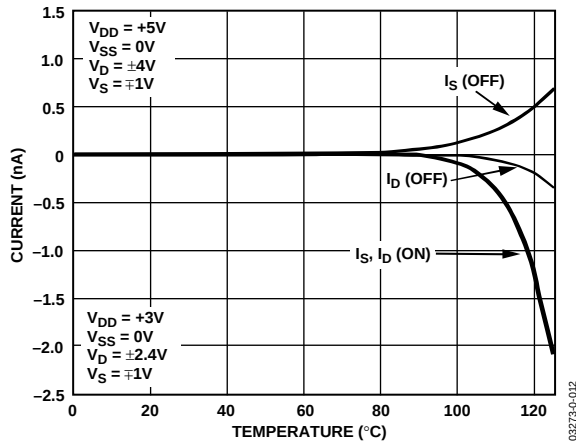


Figure 10. Leakage Current vs. Temperature (Single Supply)

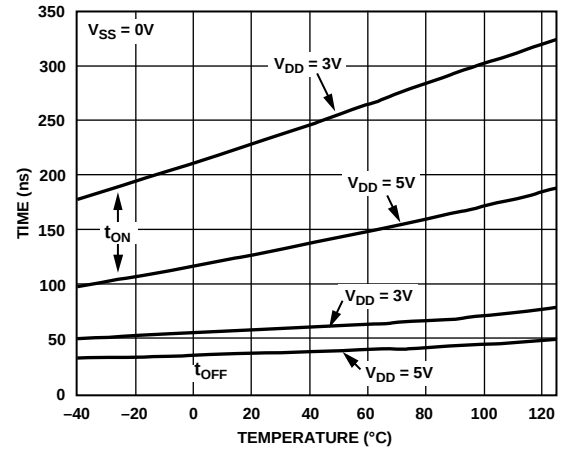


Figure 13.  $t_{ON}/t_{OFF}$  Times vs. Temperature (Single Supply)

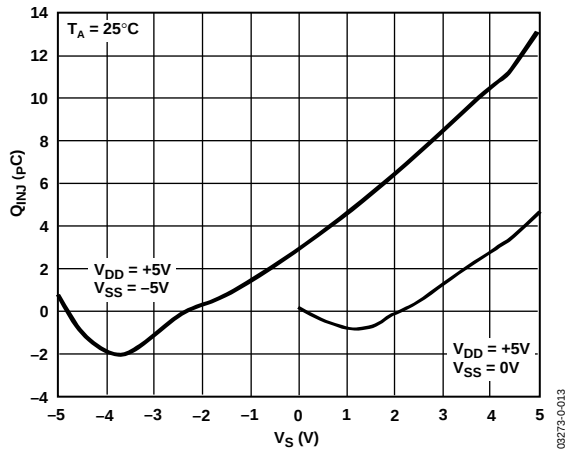


Figure 11. Charge Injection vs. Source Voltage

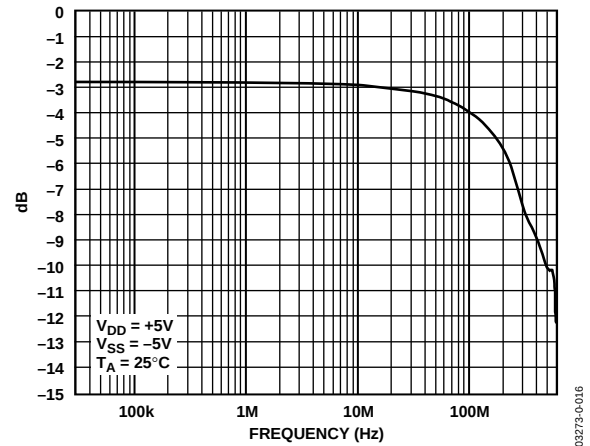


Figure 14. ON Response vs. Frequency (ADG658)

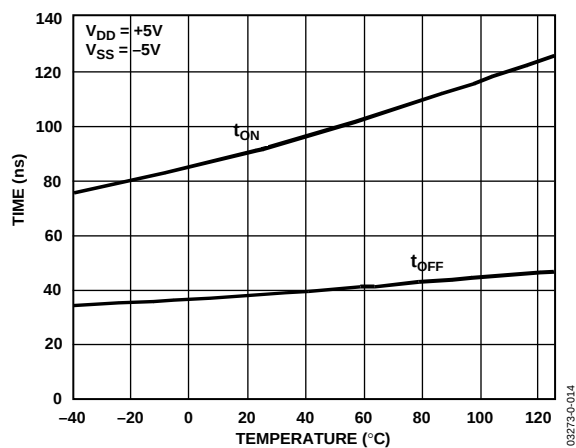


Figure 12.  $t_{ON}/t_{OFF}$  Times vs. Temperature (Dual Supply)

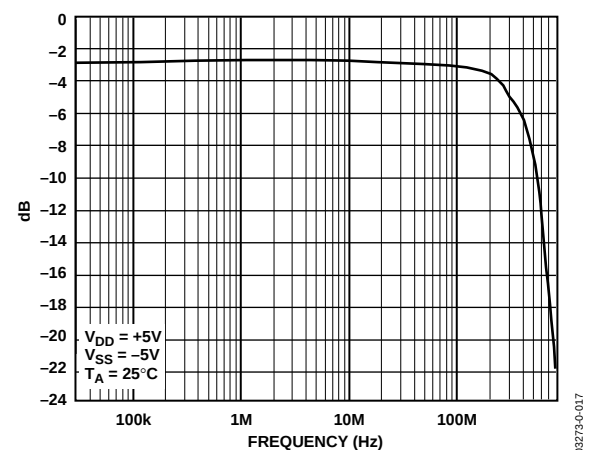


Figure 15. ON Response vs. Frequency (ADG659)

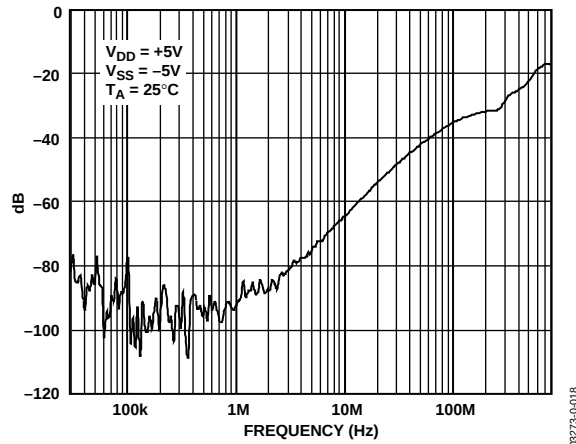


Figure 16. OFF Isolation vs. Frequency

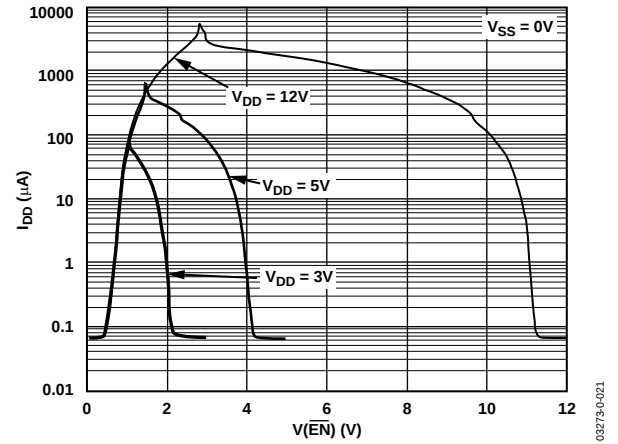


Figure 19.  $V_{DD}$  Current vs. Logic Level

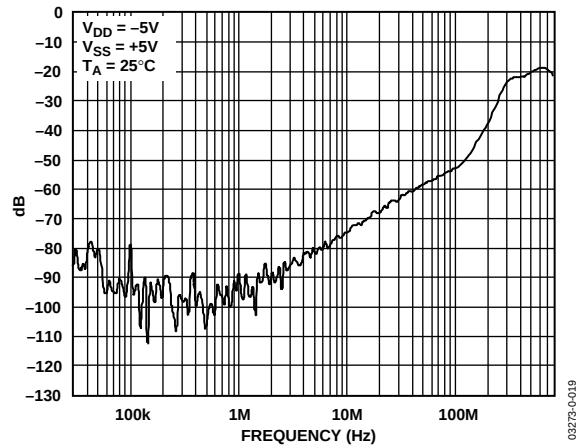


Figure 17. Crosstalk vs. Frequency

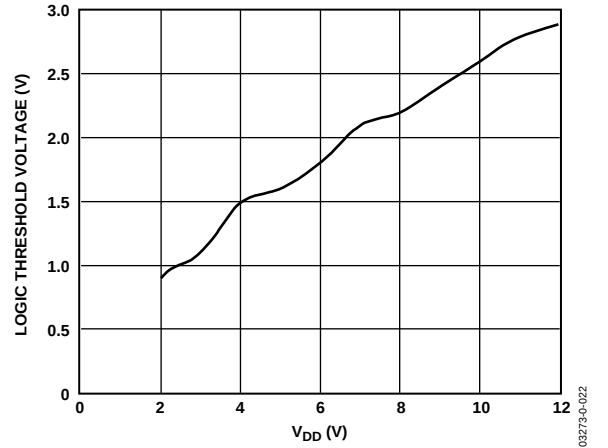


Figure 20. Logic Threshold Voltage vs. Supply Voltage

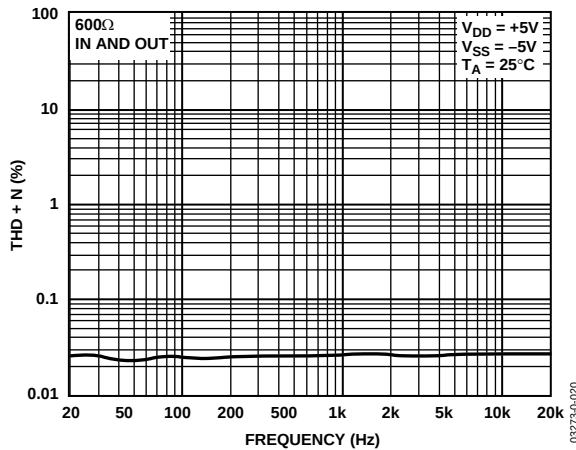


Figure 18. THD + Noise

## TEST CIRCUITS

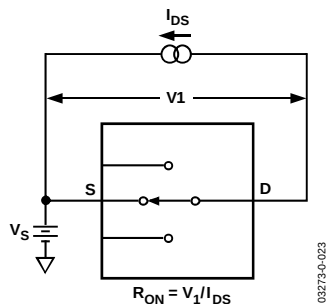


Figure 21. ON Resistance

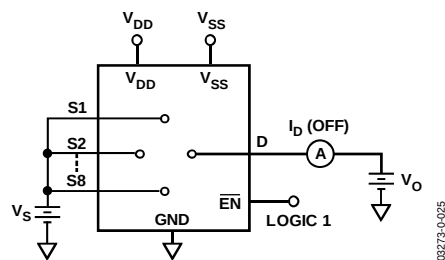


Figure 23.  $I_D$  (OFF)

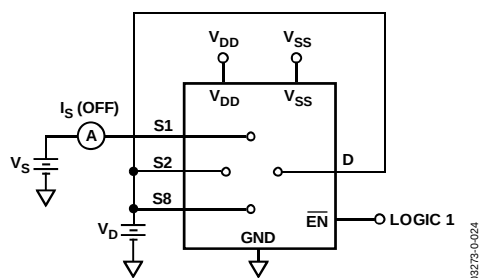


Figure 22.  $I_S$  (OFF)

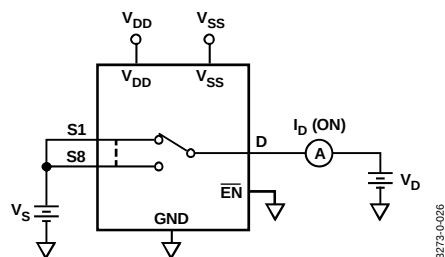


Figure 24.  $I_D$  (ON)

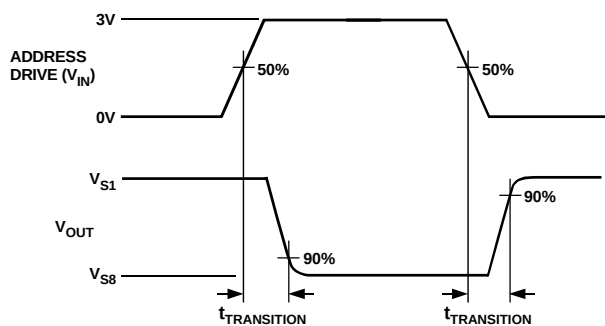
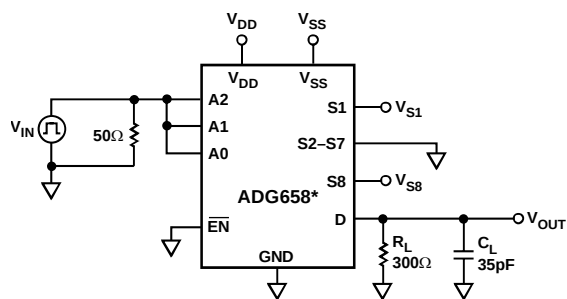
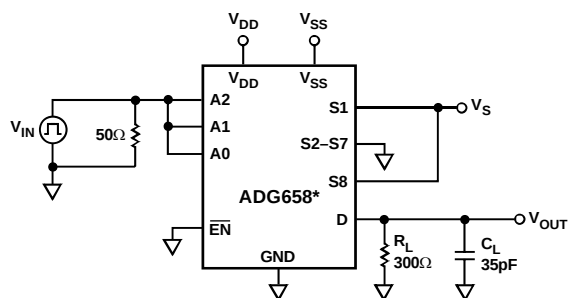
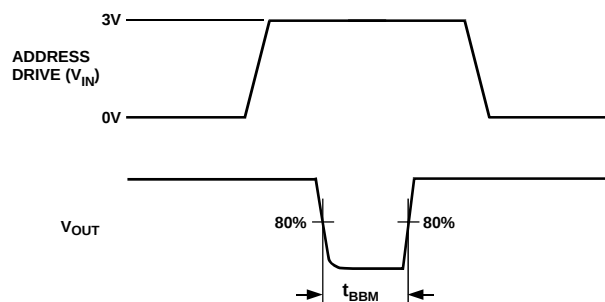


Figure 25. Switching Time of Multiplexer,  $t_{\text{TRANSITION}}$

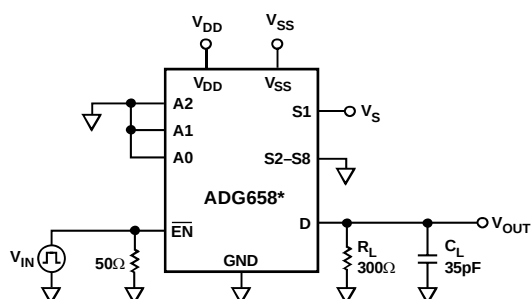


\*SIMILAR CONNECTION FOR ADG659

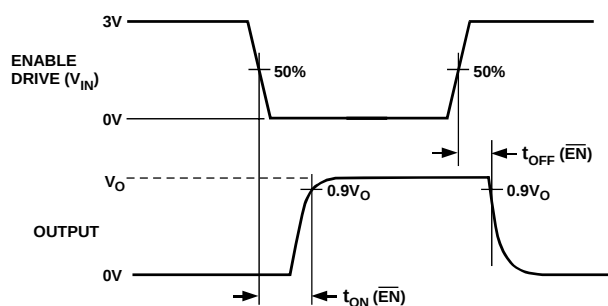


032734-028

Figure 26. Break-Before-Make Delay,  $t_{BBM}$

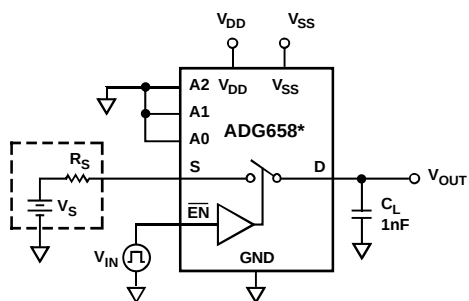


\*SIMILAR CONNECTION FOR ADG659

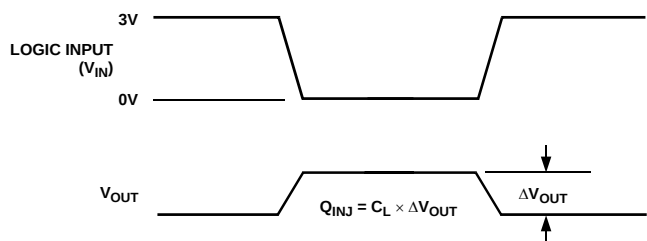


032734-029

Figure 27. Enable Delay,  $t_{ON}(\overline{EN})$ ,  $t_{OFF}(\overline{EN})$



\*SIMILAR CONNECTION FOR ADG659



032734-030

Figure 28. Charge Injection

# ADG658/ADG659

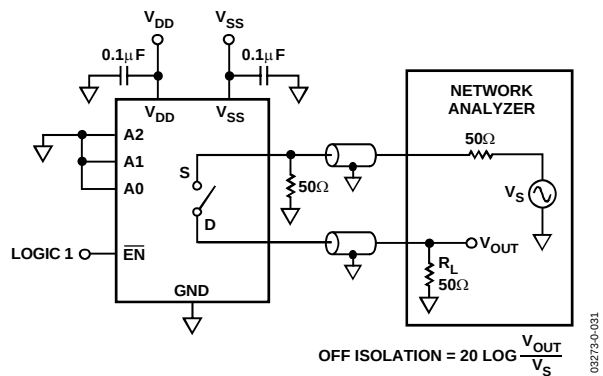


Figure 29. Off Isolation

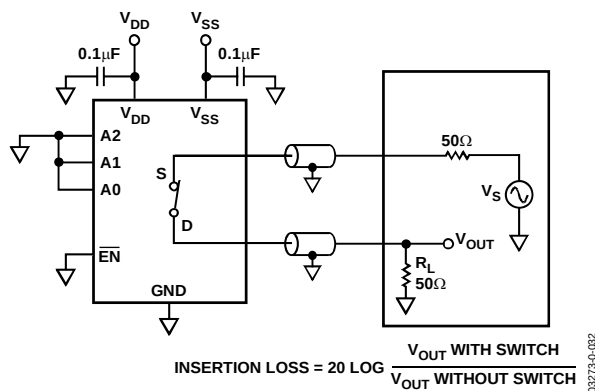


Figure 30. Bandwidth

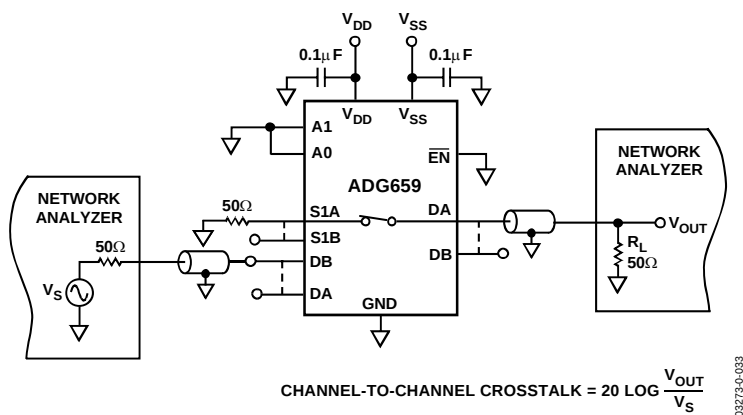


Figure 31. Channel-to-Channel Crosstalk

## OUTLINE DIMENSIONS

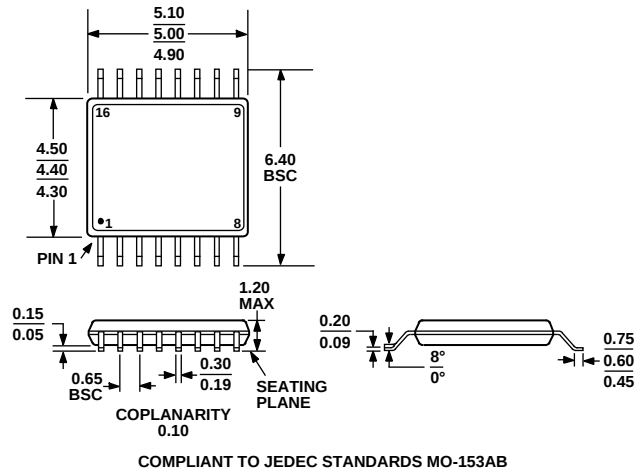


Figure 32. 16-Lead Thin Shrink Small Outline Package [TSSOP]  
(RU-16)  
Dimensions shown in millimeters

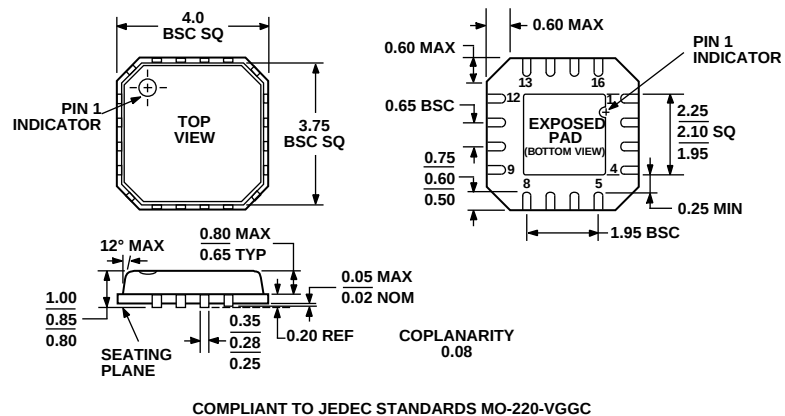


Figure 33. 16-Lead Lead Frame Chip Scale Package [LFCSP]  
(CP-16-4)  
Dimensions shown in millimeters

# ADG658/ADG659

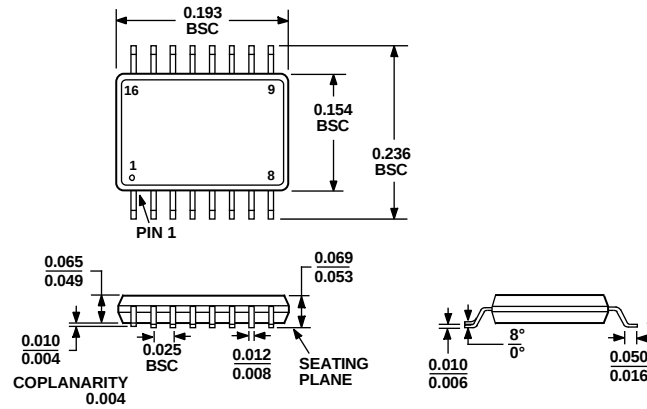


Figure 34. 16-Lead Shrink Small Outline Package [QSOP]  
(RQ-16)  
Dimensions shown in millimeters

## ORDERING GUIDE

| Model                             | Temperature Range | Package Description                               | Package Option |
|-----------------------------------|-------------------|---------------------------------------------------|----------------|
| ADG658YRU                         | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG658YRU-REEL7                   | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG658YRUZ <sup>1</sup>           | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG658YRUZ-REEL7 <sup>1</sup>     | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG658YCP                         | −40°C to +85°C    | 16-Lead Lead Frame Chip Scale Package [LFCSP]     | CP-16          |
| ADG658YCP-REEL7                   | −40°C to +85°C    | 16-Lead Lead Frame Chip Scale Package [LFCSP]     | CP-16          |
| ADG658YCPZ <sup>1</sup>           | −40°C to +85°C    | 16-Lead Lead Frame Chip Scale Package [LFCSP]     | CP-16          |
| ADG658YRQ                         | −40°C to +125°C   | 16-Lead Shrink Small Outline Package [QSOP]       | RQ-16          |
| ADG658YRQ-REEL                    | −40°C to +125°C   | 16-Lead Shrink Small Outline Package [QSOP]       | RQ-16          |
| ADG658YRQZ <sup>1</sup>           | −40°C to +125°C   | 16-Lead Shrink Small Outline Package [QSOP]       | RQ-16          |
| ADG658YRQZ-REEL7 <sup>1</sup>     | −40°C to +125°C   | 16-Lead Shrink Small Outline Package [QSOP]       | RQ-16          |
| ADG659YRU                         | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG659YRU-REEL7                   | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG659YRUZ <sup>1</sup>           | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG659YRUZ-REEL7 <sup>1</sup>     | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG659WYRUZ-REEL7 <sup>1, 2</sup> | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG659YCP                         | −40°C to +85°C    | 16-Lead Lead Frame Chip Scale Package [LFCSP]     | CP-16          |
| ADG659YCPZ <sup>1</sup>           | −40°C to +85°C    | 16-Lead Lead Frame Chip Scale Package [LFCSP]     | CP-16          |
| ADG659YCPZ-REEL7 <sup>1</sup>     | −40°C to +85°C    | 16-Lead Lead Frame Chip Scale Package [LFCSP]     | CP-16          |
| ADG659YRQ                         | −40°C to +125°C   | 16-Lead Shrink Small Outline Package [QSOP]       | RQ-16          |
| ADG659YRQ-REEL                    | −40°C to +125°C   | 16-Lead Shrink Small Outline Package [QSOP]       | RQ-16          |
| ADG659YRQ-REEL7                   | −40°C to +125°C   | 16-Lead Shrink Small Outline Package [QSOP]       | RQ-16          |
| ADG659YRQZ <sup>1</sup>           | −40°C to +125°C   | 16-Lead Shrink Small Outline Package [QSOP]       | RQ-16          |

<sup>1</sup> Z = RoHS Compliant Part.

<sup>2</sup> Qualified for automotive.