



I²C-Compatible, Wide Bandwidth, Quad, 2:1 Multiplexer

ADG791A/ADG791G

FEATURES

Bandwidth: 325 MHz
Low insertion loss and on resistance: 2.6 Ω typical
On resistance flatness: 0.3 Ω typical
Single 3 V/5 V supply operation
3.3 V analog signal range (5 V supply, 75 Ω load)
Low quiescent supply current: 1 nA typical
Fast switching times: $t_{ON} = 186$ ns, $t_{OFF} = 177$ ns
I²C[®]-compatible interface
Compact 24-lead LFCSP
ESD protection
 4 kV human body model (HBM)
 200 V machine model (MM)
 1 kV field-induced charged device model (FICDM)

APPLICATIONS

S-video RGB/YPbPr video switches
 HDTVs
 Projection TVs
 DVD-R/RW
 AV receivers

GENERAL DESCRIPTION

The ADG791A/ADG791G are monolithic CMOS devices comprising four 2:1 multiplexers/demultiplexers controllable via a standard I²C serial interface. The CMOS process provides ultralow power dissipation yet gives high switching speed and low on resistance.

The on-resistance profile is very flat over the full analog input range and wide bandwidth ensures excellent linearity and low distortion. These features, combined with a wide input signal range make the ADG791A/ADG791G the ideal switching solution for a wide range of TV applications including S-video, RGB, and YPbPr video switches.

The switches conduct equally well in both directions when on. In the off condition, signal levels up to the supplies are blocked. The ADG791A/ADG791G switches exhibit break-before-make switching action. The ADG791G has one general-purpose logic output pin controlled by the I²C interface that can also be used to control other non-I²C-compatible devices such as video filters. The integrated I²C interface provides a large degree of flexibility in the system design. It has three configurable I²C address pins

FUNCTIONAL BLOCK DIAGRAM

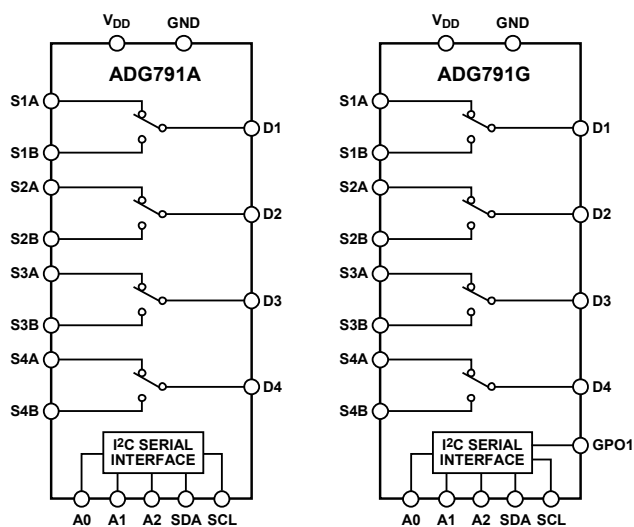


Figure 1.

that allow up to eight devices on the same bus. This allows the user to expand the capability of the device by increasing the size of the switching array.

The ADG791A/ADG791G operate from a single 3 V or 5 V supply voltage and is available in a compact 4 mm \times 4 mm body, 24-lead LFCSP.

PRODUCT HIGHLIGHTS

1. Wide bandwidth: 325 MHz.
2. Ultralow power dissipation.
3. Extended input signal range.
4. Integrated I²C serial interface.
5. Compact 4 mm \times 4 mm, 24-lead, Pb-free LFCSP.
6. ESD protection tested as per ESD association standards:
4 kV HBM (ANSI/ESD STM5.1-2001)
200 V MM (ANSI/ESD STM5.2-1999)
1 kV FICDM (ANSI/ESD STM5.3.1-1999)

Rev. 0

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REVISION HISTORY

7/06—Revision 0: Initial Version

SPECIFICATIONS

$V_{DD} = 5\text{ V} \pm 10\%$, $GND = 0\text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, unless otherwise noted.

Table 1.

| Parameter | Conditions | Min | Typ ¹ | Max | Unit |
|--|--|---------------------|----------------------|----------------------|---------------|
| ANALOG SWITCH | | | | | |
| Analog Signal Range ² | $V_S = V_{DD}$, $R_L = 1\text{ M}\Omega$ | 0 | | 4 | V |
| | $V_S = V_{DD}$, $R_L = 75\text{ }\Omega$ | 0 | | 3.3 | V |
| On Resistance, R_{ON} | $V_D = 0\text{ V}$, $I_{DS} = -10\text{ mA}$, see Figure 22 | | 2.6 | 3.5 | Ω |
| | $V_D = 0\text{ V}$ to 1 V , $I_{DS} = -10\text{ mA}$, see Figure 22 | | | 4 | Ω |
| On-Resistance Matching Between Channels, ΔR_{ON} | $V_D = 0\text{ V}$, $I_{DS} = -10\text{ mA}$ | | 0.15 | 0.5 | Ω |
| | $V_D = 1\text{ V}$, $I_{DS} = -10\text{ mA}$ | | | 0.6 | Ω |
| On-Resistance Flatness, $R_{FLAT (ON)}$ | $V_D = 0\text{ V}$ to 1 V , $I_{DS} = -10\text{ mA}$ | | 0.3 | 0.55 | Ω |
| LEAKAGE CURRENTS | | | | | |
| Source OFF Leakage ($I_{S (OFF)}$) | $V_D = 4\text{ V}/1\text{ V}$, $V_S = 1\text{ V}/4\text{ V}$, see Figure 23 | | ± 0.25 | | nA |
| Drain OFF Leakage ($I_{D (OFF)}$) | $V_D = 4\text{ V}/1\text{ V}$, $V_S = 1\text{ V}/4\text{ V}$, see Figure 23 | | ± 0.25 | | nA |
| Channel ON Leakage ($I_{D (ON)}$, $I_{S (ON)}$) | $V_D = V_S = 4\text{ V}/1\text{ V}$, see Figure 24 | | ± 0.25 | | nA |
| DYNAMIC CHARACTERISTICS³ | | | | | |
| t_{ON} , t_{ENABLE} | $C_L = 35\text{ pF}$, $R_L = 50\text{ }\Omega$, $V_S = 2\text{ V}$, see Figure 28 | | 186 | 250 | ns |
| t_{OFF} , $t_{DISABLE}$ | $C_L = 35\text{ pF}$, $R_L = 50\text{ }\Omega$, $V_S = 2\text{ V}$, see Figure 28 | | 177 | 240 | ns |
| Break-Before-Make Time Delay, t_D | $C_L = 35\text{ pF}$, $R_L = 50\text{ }\Omega$, $V_{S1} = V_{S2} = 2\text{ V}$, see Figure 29 | 1 | 3 | | ns |
| I ² C to GPO Propagation Delay, t_H , t_L | (ADG791G only) | | | 130 | ns |
| Off Isolation | $f = 10\text{ MHz}$, $R_L = 50\text{ }\Omega$, see Figure 26 | | -60 | | dB |
| Channel-to-Channel Crosstalk | $f = 10\text{ MHz}$, $R_L = 50\text{ }\Omega$, see Figure 27 | | | | |
| Same Multiplexer | | | -55 | | dB |
| Different Multiplexer | | | -70 | | dB |
| -3 dB Bandwidth | $R_L = 50\text{ }\Omega$, see Figure 25 | | 325 | | MHz |
| THD + N | $R_L = 100\text{ }\Omega$ | | 0.14 | | % |
| Charge Injection | $C_L = 1\text{ nF}$, $V_S = 0\text{ V}$, see Figure 30 | | 5 | | pC |
| $C_S (OFF)$ | | | 10 | | pF |
| $C_D (OFF)$ | | | 13 | | pF |
| $C_D (ON)$, $C_S (ON)$ | | | 27 | | pF |
| Power Supply Rejection Ratio, PSRR | $f = 20\text{ kHz}$ | | 70 | | dB |
| Differential Gain Error | CCIR330 test signal | | 0.32 | | % |
| Differential Phase Error | CCIR330 test signal | | 0.44 | | Degrees |
| LOGIC INPUTS³ | | | | | |
| A0, A1, A2 | | 2.0 | | | V |
| Input High Voltage, V_{INH} | | | | 0.8 | V |
| Input Low Voltage, V_{INL} | | | 0.005 | ± 1 | μA |
| Input Current, I_{INL} or I_{INH} | $V_{IN} = 0\text{ V}$ to V_{DD} | | 3 | | pF |
| Input Capacitance, C_{IN} | | | | | |
| SCL, SDA | | | | | |
| Input High Voltage, V_{INH} | | $0.7 \times V_{DD}$ | | $V_{DD} + 0.3$ | V |
| Input Low Voltage, V_{INL} | | -0.3 | | $+0.3 \times V_{DD}$ | V |
| Input Leakage Current, I_{IN} | $V_{IN} = 0\text{ V}$ to V_{DD} | | 0.005 | ± 1 | μA |
| Input Hysteresis | | | $0.05 \times V_{DD}$ | | V |
| Input Capacitance, C_{IN} | | | 3 | | pF |

ADG791A/ADG791G

| Parameter | Conditions | Min | Typ ¹ | Max | Unit |
|-----------------------------------|--|-----|------------------|---------|---------------|
| LOGIC OUTPUTS ³ | | | | | |
| SDA Pin | | | | | |
| Output Low Voltage, V_{OL} | $I_{SINK} = 3 \text{ mA}$ | | | 0.4 | V |
| | $I_{SINK} = 6 \text{ mA}$ | | | 0.6 | V |
| Floating-State Leakage Current | | | | ± 1 | μA |
| Floating-State Output Capacitance | | | | 10 | pF |
| GPO1 Pin and GPO2 Pin | | | | | |
| Output Low Voltage, V_{OL} | $I_{LOAD} = +2 \text{ mA}$ | | | 0.4 | V |
| Output High Voltage, V_{OH} | $I_{LOAD} = -2 \text{ mA}$ | 2.0 | | | V |
| POWER REQUIREMENTS | | | | | |
| I_{DD} | Digital inputs = 0 V or V_{DD} , I ² C interface inactive | | 0.001 | 1 | μA |
| | I ² C interface active, $f_{SCL} = 400 \text{ kHz}$ | | | 0.2 | mA |
| | I ² C interface active, $f_{SCL} = 3.4 \text{ MHz}$ | | | 0.7 | mA |

¹All typical values are at $T_A = 25^\circ\text{C}$, unless otherwise stated.

²Guaranteed by initial characterization, not subject to production test.

³Guaranteed by design, not subject to production test.

$V_{DD} = 3 \text{ V} \pm 10\%$, $GND = 0 \text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, unless otherwise noted.

Table 2.

| Parameter | Conditions | Min | Typ ¹ | Max | Unit |
|---|---|---------------------|----------------------|----------------------|---------------|
| ANALOG SWITCH | | | | | |
| Analog Signal Range ² | $V_S = V_{DD}$, $R_L = 1 \text{ M}\Omega$ | 0 | | 2.2 | V |
| | $V_S = V_{DD}$, $R_L = 75 \Omega$ | 0 | | 1.7 | V |
| On Resistance, R_{ON} | $V_D = 0 \text{ V}$, $I_{DS} = -10 \text{ mA}$, see Figure 22 | | 3 | 4 | Ω |
| | $V_D = 0 \text{ V}$ to 1 V , $I_{DS} = -10 \text{ mA}$, see Figure 22 | | | 6 | Ω |
| On-Resistance Matching Between Channels, ΔR_{ON} | $V_D = 0 \text{ V}$, $I_{DS} = -10 \text{ mA}$ | | 0.15 | 0.6 | Ω |
| | $V_D = 1 \text{ V}$, $I_{DS} = -10 \text{ mA}$ | | | 1.1 | Ω |
| On-Resistance Flatness, $R_{FLAT (ON)}$ | $V_D = 0 \text{ V}$ to 1 V , $I_{DS} = -10 \text{ mA}$ | | 0.8 | 2.8 | Ω |
| LEAKAGE CURRENTS | | | | | |
| Source Off Leakage ($I_{S (OFF)}$) | $V_D = 2 \text{ V}/1 \text{ V}$, $V_S = 1 \text{ V}/2 \text{ V}$, see Figure 23 | | ± 0.25 | | nA |
| Drain Off Leakage ($I_{D (OFF)}$) | $V_D = 2 \text{ V}/1 \text{ V}$, $V_S = 1 \text{ V}/2 \text{ V}$, see Figure 23 | | ± 0.25 | | nA |
| Channel On Leakage ($I_{D (ON)}$, $I_{S (ON)}$) | $V_D = V_S = 2 \text{ V}/1 \text{ V}$, see Figure 24 | | ± 0.25 | | nA |
| DYNAMIC CHARACTERISTICS³ | | | | | |
| t_{ON} , t_{ENABLE} | $C_L = 35 \text{ pF}$, $R_L = 50 \Omega$, $V_S = 2 \text{ V}$, see Figure 28 | | 198 | 270 | ns |
| t_{OFF} , $t_{DISABLE}$ | $C_L = 35 \text{ pF}$, $R_L = 50 \Omega$, $V_S = 2 \text{ V}$, see Figure 28 | | 195 | 260 | ns |
| Break-Before-Make Time Delay, t_D | $C_L = 35 \text{ pF}$, $R_L = 50 \Omega$, $V_{S1} = V_{S2} = 2 \text{ V}$, see Figure 29 | 1 | 3 | | ns |
| I ² C to GPO Propagation Delay, t_H , t_L (ADG791G only) | | | | 121 | ns |
| Off Isolation | $f = 10 \text{ MHz}$, $R_L = 50 \Omega$, see Figure 26 | | -60 | | dB |
| Channel-to-Channel Crosstalk | $f = 10 \text{ MHz}$, $R_L = 50 \Omega$, see Figure 27 | | | | |
| Same Multiplexer | | | -55 | | dB |
| Different Multiplexer | | | -70 | | dB |
| -3 dB Bandwidth | $R_L = 50 \Omega$, see Figure 25 | | 310 | | MHz |
| THD + N | $R_L = 100 \Omega$ | | 0.14 | | % |
| Charge Injection | $C_L = 1 \text{ nF}$, $V_S = 0 \text{ V}$, see Figure 30 | | 2.5 | | pC |
| $C_{S (OFF)}$ | | | 10 | | pF |
| $C_{D (OFF)}$ | | | 13 | | pF |
| $C_{D (ON)}$, $C_{S (ON)}$ | | | 27 | | pF |
| Power Supply Rejection Ratio, PSRR | $f = 20 \text{ kHz}$ | | 70 | | dB |
| Differential Gain Error | CCIR330 test signal | | 0.28 | | % |
| Differential Phase Error | CCIR330 test signal | | 0.28 | | Degrees |
| LOGIC INPUTS³ | | | | | |
| A0, A1, A2 | | 2.0 | | | V |
| Input High Voltage, V_{INH} | | | | 0.8 | V |
| Input Low Voltage, V_{INL} | | | 0.005 | ± 1 | μA |
| Input Current, I_{INL} or I_{INH} | $V_{IN} = 0 \text{ V}$ to V_{DD} | | 3 | | pF |
| Input Capacitance, C_{IN} | | | | | |
| SCL, SDA | | | | | |
| Input High Voltage, V_{INH} | | $0.7 \times V_{DD}$ | | $V_{DD} + 0.3$ | V |
| Input Low Voltage, V_{INL} | | -0.3 | | $+0.3 \times V_{DD}$ | V |
| Input Leakage Current, I_{IN} | $V_{IN} = 0 \text{ V}$ to V_{DD} | | 0.005 | ± 1 | μA |
| Input Hysteresis | | | $0.05 \times V_{DD}$ | | V |
| Input Capacitance, C_{IN} | | | 3 | | pF |

ADG791A/ADG791G

| Parameter | Conditions | Min | Typ ¹ | Max | Unit |
|-----------------------------------|--|-----|------------------|---------|---------------|
| LOGIC OUTPUTS ³ | | | | | |
| SDA Pin | | | | | |
| Output Low Voltage, V_{OL} | $I_{SINK} = 3 \text{ mA}$ | | | 0.4 | V |
| | $I_{SINK} = 6 \text{ mA}$ | | | 0.6 | V |
| Floating-State Leakage Current | | | | ± 1 | μA |
| Floating-State Output Capacitance | | | 3 | | pF |
| GPO1 Pin and GPO2 Pin | | | | | |
| Output Low Voltage, V_{OL} | $I_{LOAD} = +2 \text{ mA}$ | | | 0.4 | V |
| Output High Voltage, V_{OH} | $I_{LOAD} = -2 \text{ mA}$ | 2.0 | | | V |
| POWER REQUIREMENTS | | | | | |
| I_{DD} | Digital inputs = 0 V or V_{DD} , I ² C interface inactive | | 0.001 | 1 | μA |
| | I ² C interface active, $f_{SCL} = 400 \text{ kHz}$ | | | 0.1 | mA |
| | I ² C interface active, $f_{SCL} = 3.4 \text{ MHz}$ | | | 0.2 | mA |

¹All typical values are at $T_A = 25^\circ\text{C}$, unless otherwise stated.

²Guaranteed by initial characterization, not subject to production test.

³Guaranteed by design, not subject to production test.

I²C TIMING SPECIFICATIONS

$V_{DD} = 2.7\text{ V to }5.5\text{ V}$; $GND = 0\text{ V}$; $T_A = -40^{\circ}\text{C to }+85^{\circ}\text{C}$, unless otherwise noted. See Figure 2 for timing diagram.

Table 3.

| Parameter ¹ | Conditions | Min | Max | Unit | Description |
|------------------------|---------------------------|----------------|------|---------------|--|
| f_{SCL} | Standard mode | | 100 | kHz | Serial clock frequency |
| | Fast mode | | 400 | kHz | |
| | High speed mode | | | | |
| | $C_B = 100\text{ pF max}$ | | 3.4 | MHz | |
| | $C_B = 400\text{ pF max}$ | | 1.7 | MHz | |
| t_1 | Standard mode | 4 | | μs | t_{HIGH} , SCL high time |
| | Fast mode | 0.6 | | μs | |
| | High speed mode | | | | |
| | $C_B = 100\text{ pF max}$ | 60 | | ns | |
| | $C_B = 400\text{ pF max}$ | 120 | | ns | |
| t_2 | Standard mode | 4.7 | | μs | t_{LOW} , SCL low time |
| | Fast mode | 1.3 | | μs | |
| | High speed mode | | | | |
| | $C_B = 100\text{ pF max}$ | 160 | | ns | |
| | $C_B = 400\text{ pF max}$ | 320 | | ns | |
| t_3 | Standard mode | 250 | | ns | $t_{SU,DAT}$, data setup time |
| | Fast mode | 100 | | ns | |
| | High speed mode | 10 | | ns | |
| t_4^2 | Standard mode | 0 | 3.45 | μs | $t_{HD,DAT}$, data hold time |
| | Fast mode | 0 | 0.9 | μs | |
| | High speed mode | | | | |
| | $C_B = 100\text{ pF max}$ | 0 | 703 | ns | |
| | $C_B = 400\text{ pF max}$ | 0 | 150 | ns | |
| t_5 | Standard mode | 4.7 | | μs | $t_{SU,STA}$, setup time for a repeated start condition |
| | Fast mode | 0.6 | | μs | |
| | High speed mode | 160 | | ns | |
| t_6 | Standard mode | 4 | | μs | $t_{HD,STA}$, hold time (repeated) start condition |
| | Fast mode | 0.6 | | μs | |
| | High speed mode | 160 | | ns | |
| t_7 | Standard mode | 4.7 | | μs | t_{BUF} , bus free time between a stop and a start condition |
| | Fast mode | 1.3 | | μs | |
| t_8 | Standard mode | 4 | | μs | $t_{SU,STO}$, setup time for stop condition |
| | Fast mode | 0.6 | | μs | |
| | High speed mode | 160 | | ns | |
| t_9 | Standard mode | | 1000 | ns | t_{RDA} , rise time of SDA signal |
| | Fast mode | $20 + 0.1 C_B$ | 300 | ns | |
| | High speed mode | | | | |
| | $C_B = 100\text{ pF max}$ | 10 | 80 | ns | |
| | $C_B = 400\text{ pF max}$ | 20 | 160 | ns | |
| t_{10} | Standard mode | | 300 | ns | t_{FDA} , fall time of SDA signal |
| | Fast mode | $20 + 0.1 C_B$ | 300 | ns | |
| | High speed mode | | | | |
| | $C_B = 100\text{ pF max}$ | 10 | 80 | ns | |
| | $C_B = 400\text{ pF max}$ | 20 | 160 | ns | |
| t_{11} | Standard mode | | 1000 | ns | t_{RCL} , rise time of SCL signal |
| | Fast mode | $20 + 0.1 C_B$ | 300 | ns | |
| | High speed mode | | | | |
| | $C_B = 100\text{ pF max}$ | 10 | 40 | ns | |
| | $C_B = 400\text{ pF max}$ | 20 | 80 | ns | |

ADG791A/ADG791G

| Parameter ¹ | Conditions | Min | Max | Unit | Description |
|------------------------|----------------------------|----------------|------|------|---|
| t_{11A} | Standard mode | | 1000 | ns | t_{RCL1} , rise time of SCL signal after a repeated start condition and after an acknowledge bit. |
| | Fast mode | $20 + 0.1 C_B$ | 300 | ns | |
| | High speed mode | | | | |
| | $C_B = 100 \text{ pF max}$ | 10 | 80 | ns | |
| | $C_B = 400 \text{ pF max}$ | 20 | 160 | ns | |
| t_{12} | Standard mode | | 300 | ns | t_{FCL} , fall time of SCL signal |
| | Fast mode | $20 + 0.1 C_B$ | 300 | ns | |
| | High speed mode | | | | |
| | $C_B = 100 \text{ pF max}$ | 10 | 40 | ns | |
| | $C_B = 400 \text{ pF max}$ | 20 | 80 | ns | |
| t_{SP} | Fast mode | 0 | 50 | ns | Pulse width of suppressed spike |
| | High speed mode | 0 | 10 | ns | |

¹ Guaranteed by initial characterization. C_B refers to capacitive load on the bus line, t_r and t_f measured between 0.3 V_{DD} and 0.7 V_{DD} .

² A device must provide a data hold time for SDA to bridge the undefined region of the SCL falling edge.

TIMING DIAGRAM

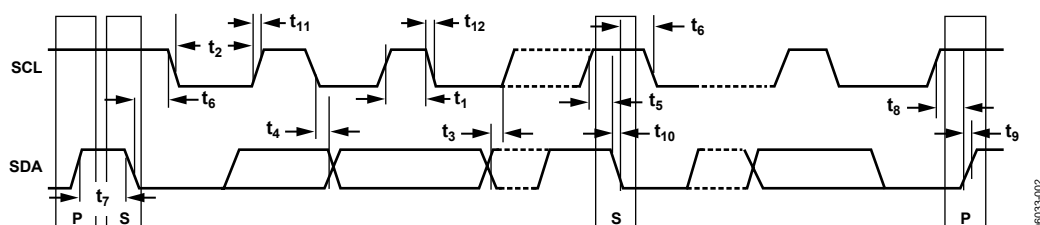


Figure 2. Timing Diagram for 2-Wire Serial Interface

ABSOLUTE MAXIMUM RATINGS

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

Table 4.

| Parameter | Ratings |
|---------------------------------------|---|
| V_{DD} to GND | −0.3 V to +6 V |
| Analog, Digital Inputs | −0.3 V to $V_{DD} + 0.3$ V or 30 mA, whichever occurs first |
| Continuous Current, S or D | 100 mA |
| Peak Current, S or D | 300 mA (pulsed at 1 ms, 10% duty cycle max) |
| Operating Temperature Range | |
| Industrial (B Version) | −40°C to +85°C |
| Storage Temperature Range | −65°C to +150°C |
| Junction Temperature | 150°C |
| θ_{JA} Thermal Impedance | |
| 24-Lead LFCSP | 30°C/W |
| Lead Temperature, Soldering (10 sec) | 300°C |
| IR Reflow, Peak Temperature (<20 sec) | 260°C |

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.

Only one absolute maximum rating may be applied at any one time.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



ADG791A/ADG791G

PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

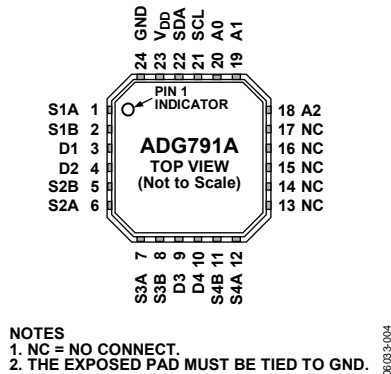


Figure 3. ADG791G Pin Configuration

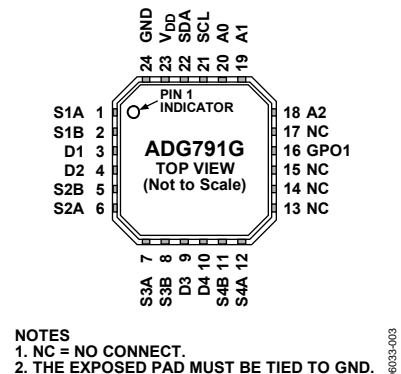


Figure 4. ADG791A Pin Configuration

Table 5. ADG791A/ADG791G Pin Function Descriptions

| Pin No. | Mnemonic | Description |
|---------|-----------------|--|
| 1 | S1A | A-Side Source Terminal for Mux 1. Can be an input or output. |
| 2 | S1B | B-Side Source Terminal for Mux 1. Can be an input or output. |
| 3 | D1 | Drain Terminal for Mux 1. Can be an input or output. |
| 4 | D2 | Drain Terminal for Mux 2. Can be an input or output. |
| 5 | S2B | B-Side Source Terminal for Mux 2. Can be an input or output. |
| 6 | S2A | A-Side Source Terminal for Mux 2. Can be an input or output. |
| 7 | S3A | A-Side Source Terminal for Mux 3. Can be an input or output. |
| 8 | S3B | B-Side Source Terminal for Mux 3. Can be an input or output. |
| 9 | D3 | Drain Terminal for Mux 3. Can be an input or output. |
| 10 | D4 | Drain Terminal for Mux 4. Can be an input or output. |
| 11 | S4B | B-Side Source Terminal for Mux 4. Can be an input or output. |
| 12 | S4A | A-Side Source Terminal for Mux 4. Can be an input or output. |
| 13 | NC | Not Internally Connected. |
| 14 | NC | Not Internally Connected. |
| 15 | NC | Not Internally Connected. |
| 16 | NC/GPO1 | Not Internally Connected for ADG791A/General-Purpose Logic Output 1 for ADG791G. |
| 17 | NC | Not Internally Connected. |
| 18 | A2 | Logic Input. Sets Bit A2 from the least significant bit of the 7-bit slave address. |
| 19 | A1 | Logic Input. Sets Bit A1 from the least significant bit of the 7-bit slave address. |
| 20 | A0 | Logic Input. Sets Bit A0 from the least significant bit of the 7-bit slave address. |
| 21 | SCL | Digital Input, Serial Clock Line. Open-drain input that is used in conjunction with SDA to clock data into the device. External pull-up resistor required. |
| 22 | SDA | Digital I/O. Bidirectional, open-drain data line. External pull-up resistor required. |
| 23 | V _{DD} | Positive Power Supply Input. |
| 24 | GND | Ground (0 V) Reference. |

TYPICAL PERFORMANCE CHARACTERISTICS

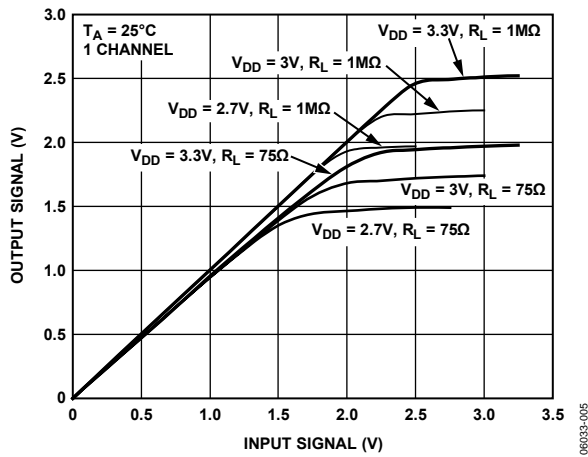


Figure 5. Analog Signal Range, 3 V Supply

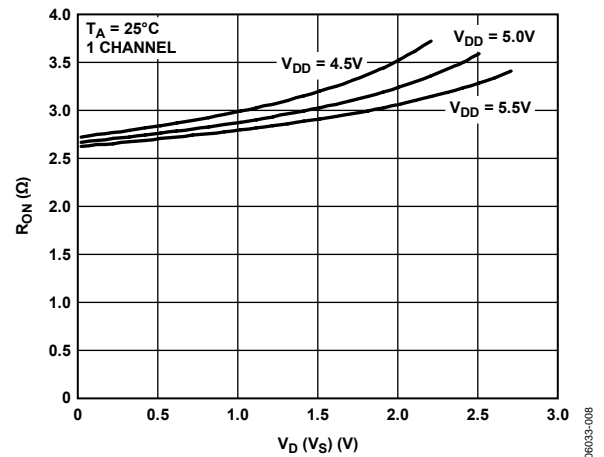


Figure 8. On Resistance vs. V_D (V_S), 5 V Supply

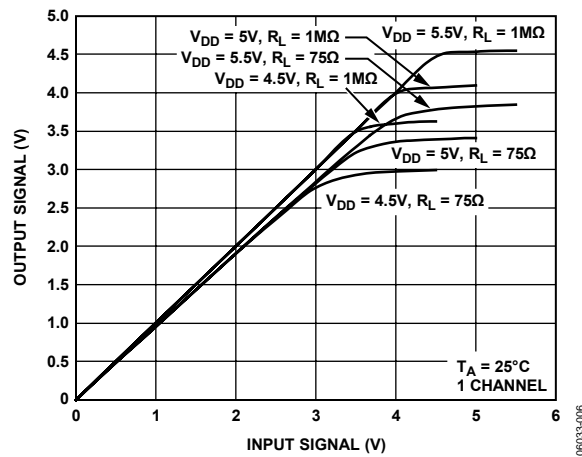


Figure 6. Analog Signal Range, 5 V Supply

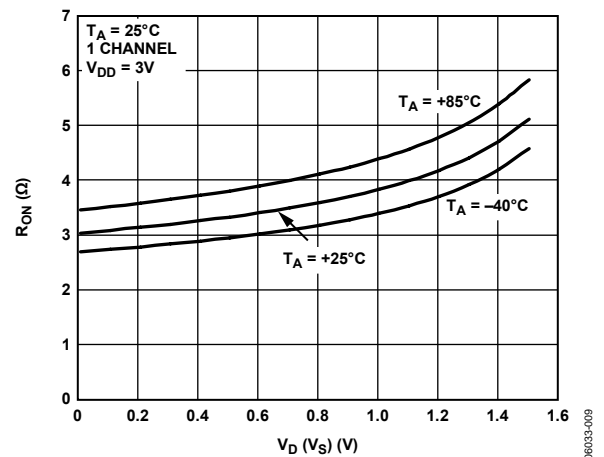


Figure 9. On Resistance vs. V_D (V_S) for Various Temperatures, 3 V Supply

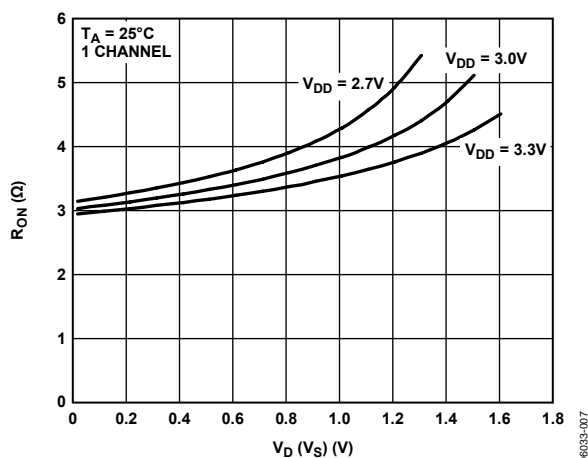


Figure 7. On Resistance vs. V_D (V_S), 3 V Supply

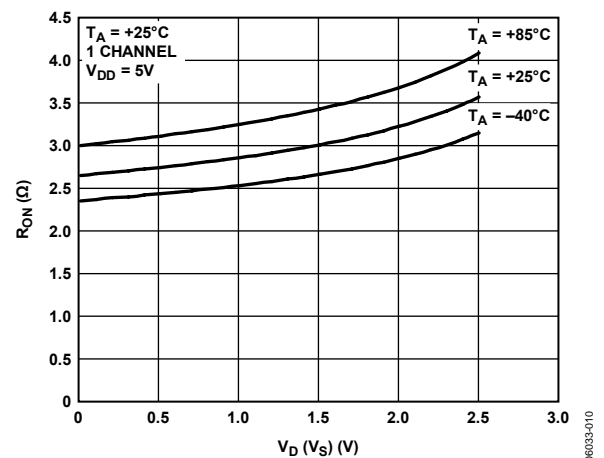


Figure 10. On Resistance vs. V_D (V_S) for Various Temperatures, 5 V Supply

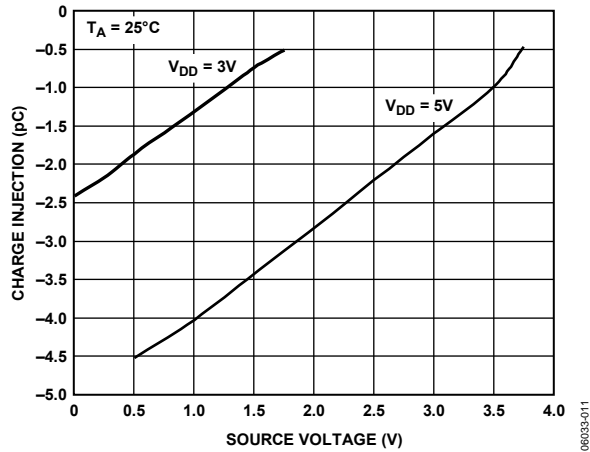


Figure 11. Charge Injection vs. Source Voltage

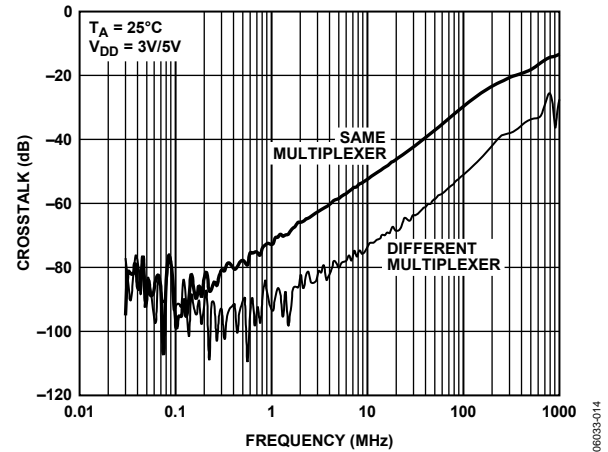


Figure 14. Crosstalk vs. Frequency

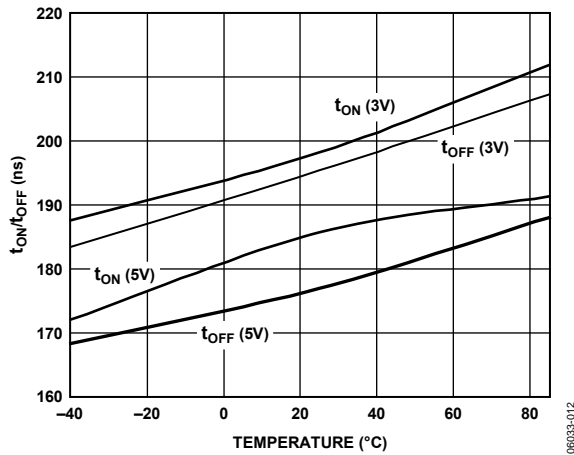


Figure 12. t_{ON}/t_{OFF} vs. Temperature

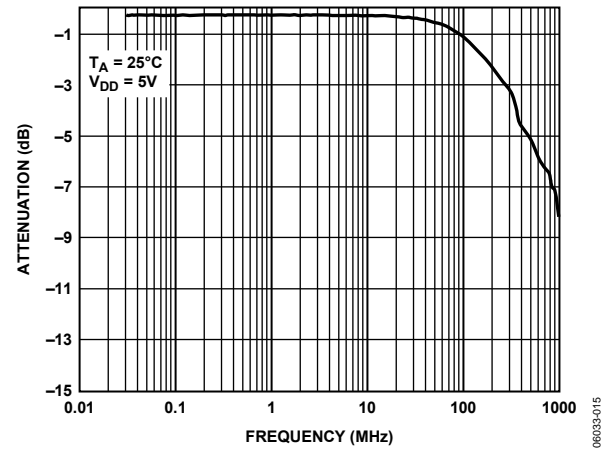


Figure 15. Bandwidth

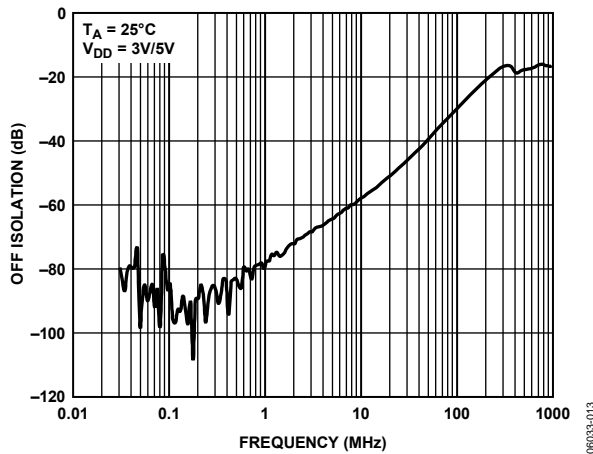


Figure 13. Off Isolation vs. Frequency

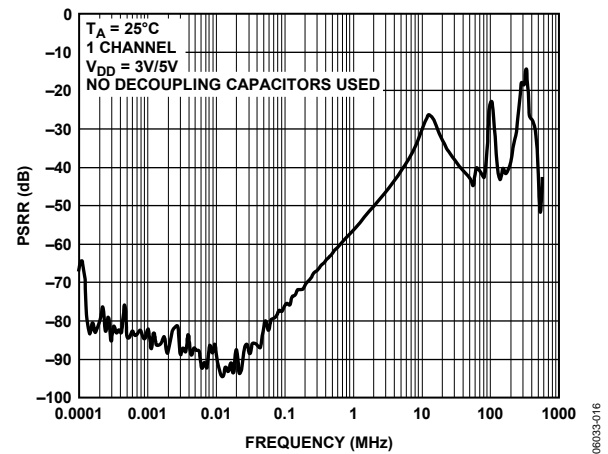


Figure 16. PSRR vs. Frequency

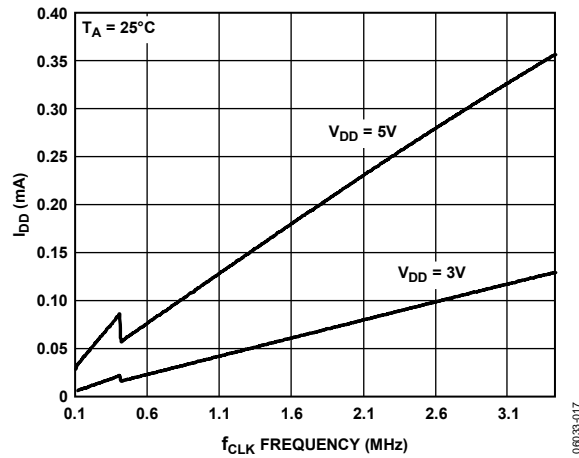


Figure 17. I_{DD} vs. f_{CLK} Frequency

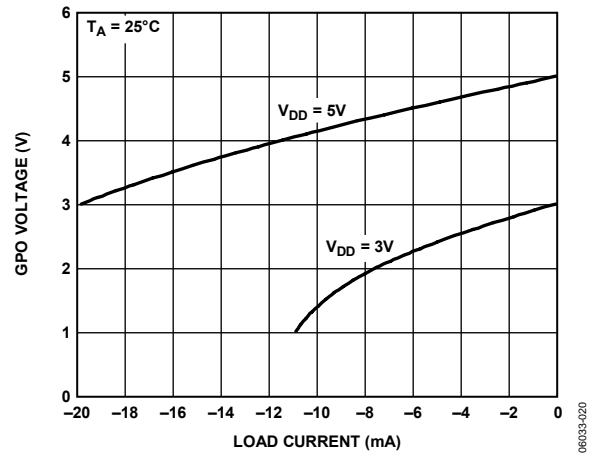


Figure 20. GPO V_{OH} vs. Load Current

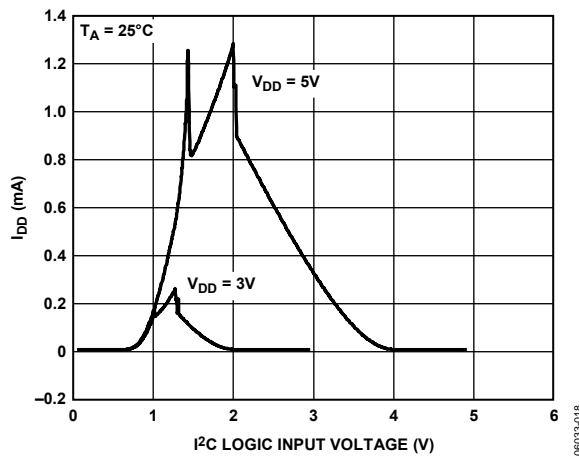


Figure 18. I_{DD} vs. I^2C Logic Input Voltage (SDA, SCL)

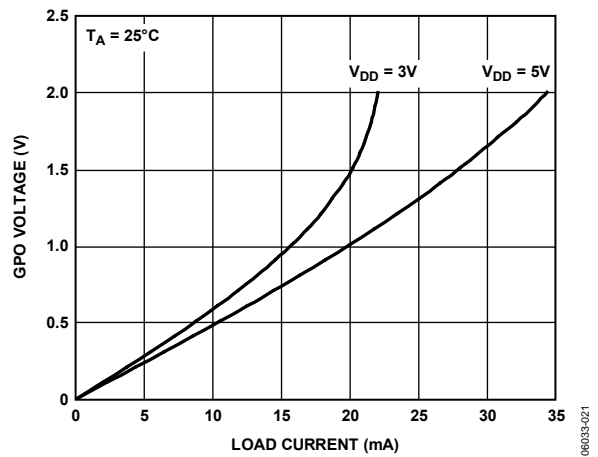


Figure 21. GPO V_{OL} vs. Load Current

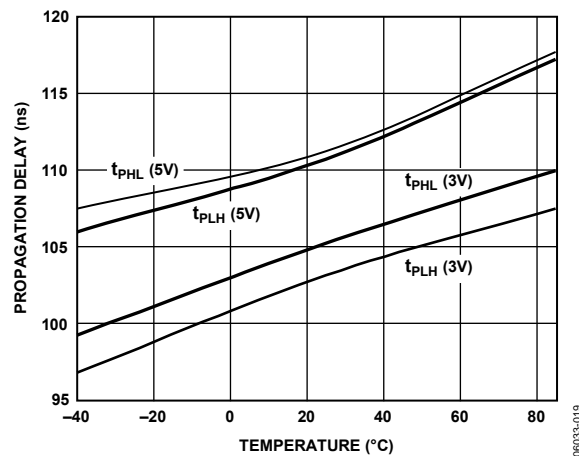


Figure 19. I^2C to GPO Propagation Delay vs. Temperature (ADG791G Only)

TEST CIRCUITS

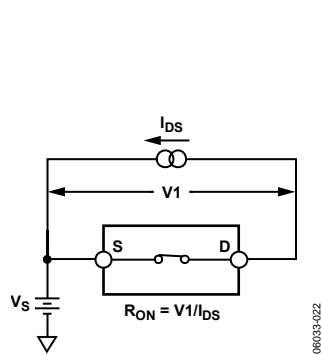


Figure 22. On Resistance

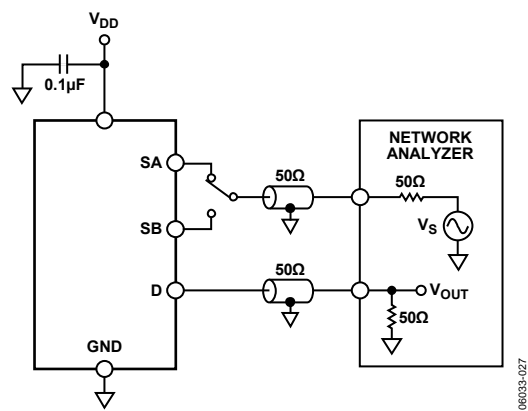


Figure 25. Bandwidth

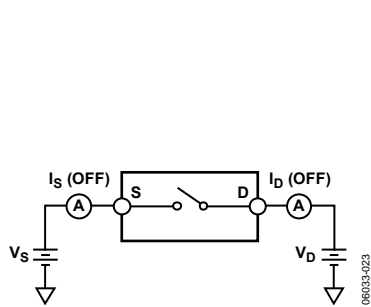


Figure 23. Off Leakage

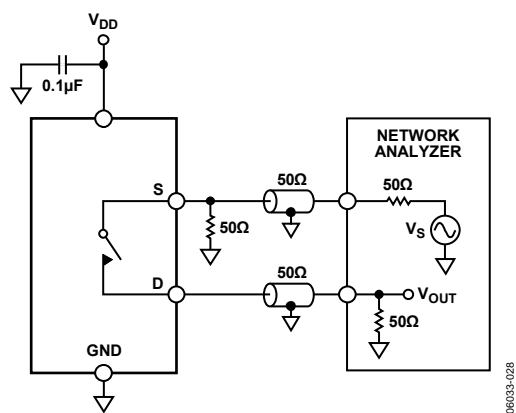


Figure 26. Off Isolation

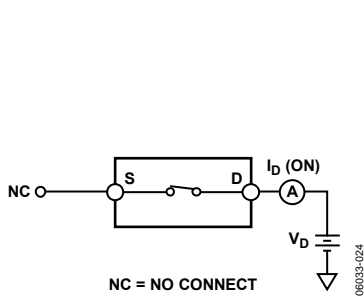


Figure 24. On Leakage

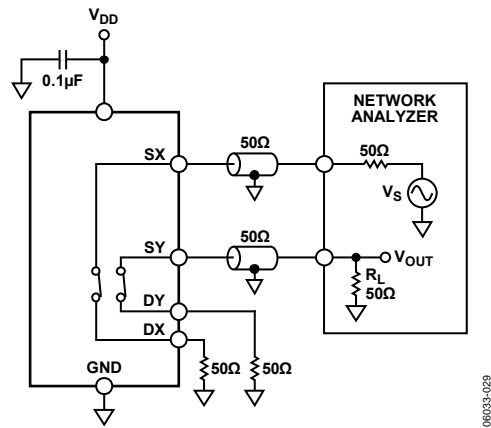


Figure 27. Channel-to-Channel Crosstalk

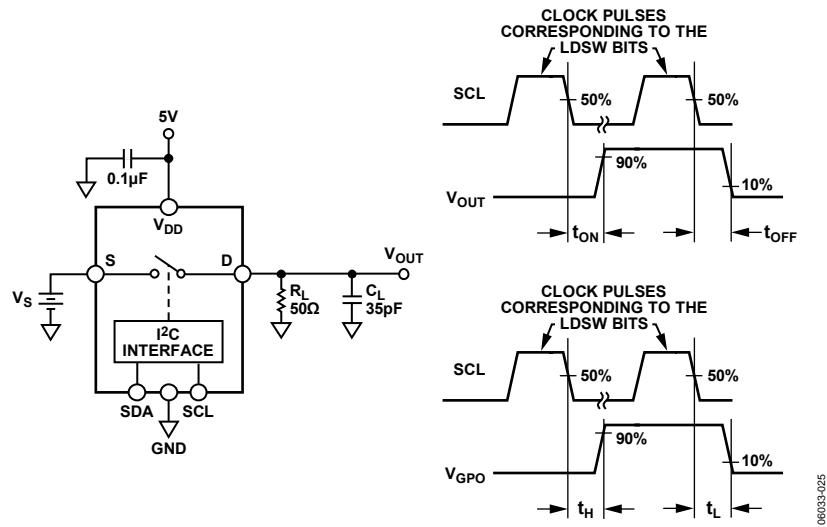


Figure 28. Switching Time

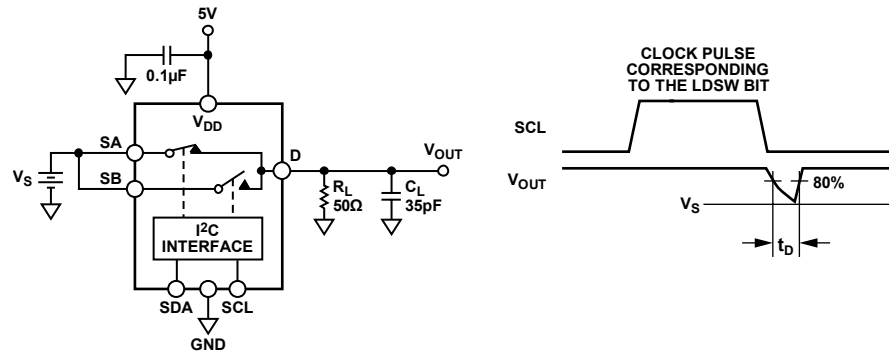


Figure 29. Break-Before-Make Time Delay

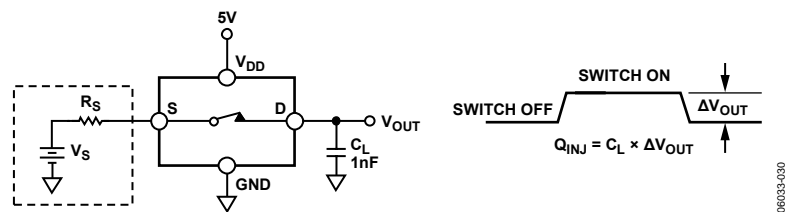


Figure 30. Charge Injection

TERMINOLOGY

On Resistance (R_{ON})

The series on-channel resistance measured between the S and D pins.

On Resistance Match (ΔR_{ON})

The channel-to-channel matching of on resistance when channels are operated under identical conditions.

On Resistance Flatness ($R_{FLAT(ON)}$)

The variation of on resistance over the specified range produced by the specified analog input voltage change with a constant load current.

Channel Off Leakage (I_{OFF})

The sum of leakage currents into or out of an off channel input.

Channel On Leakage (I_{ON})

The current loss/gain through an on-channel resistance, creating a voltage offset across the device.

Input Leakage Current (I_{IN} , I_{INL} , I_{INH})

The current flowing into a digital input when a specified low level or high level voltage is applied to that input.

Input/Output Off Capacitance (C_{OFF})

The capacitance between an analog input and ground when the switch channel is off.

Input/Output On Capacitance (C_{ON})

The capacitance between the inputs or outputs and ground when the switch channel is on.

Digital Input Capacitance (C_{IN})

The capacitance between a digital input and ground.

Output On Switching Time (t_{ON})

The time required for the switch channel to close. The time is measured from 50% of the falling edge of the LDSW bit to the time the output reaches 90% of the final value.

Output Off Switching Time (t_{OFF})

The time required for the switch to open. The time is measured from 50% of the falling edge of the LDSW bit to the time the output reaches 10% of the final value.

I²C to GPO Propagation Delay (t_H , t_L)

The time required for the logic value at the GPO pin to settle after loading a GPO command. The time is measured from 50% of the falling edge of the LDSW bit to the time the output reaches 90% of the final value for high and 10% for low.

Total Harmonic Distortion + Noise (THD + N)

The ratio of the harmonic amplitudes plus noise of a signal to the fundamental.

–3 dB Bandwidth

The frequency at which the output is attenuated by 3 dB.

Off Isolation

The measure of unwanted signal coupling through an off switch.

Crosstalk

The measure of unwanted signal that is coupled through from one channel to another as a result of parasitic capacitance.

Charge Injection

The measure of the glitch impulse transferred from the digital input to the analog output during on/off switching.

Differential Gain Error

The measure of how much color saturation shift occurs when the luminance level changes. Both attenuation and amplification can occur; therefore, the largest amplitude change between any two levels is specified and expressed in %.

Differential Phase Error

The measure of how much hue shift occurs when the luminance level changes. It can be a negative or positive value and is expressed in degrees of subcarrier phase.

Input High Voltage (V_{INH})

The minimum input voltage for Logic 1.

Input Low Voltage (V_{INL})

The maximum input voltage for Logic 0.

Output High Voltage (V_{OH})

The minimum output voltage for Logic 1.

Output Low Voltage (V_{OL})

The maximum output voltage for Logic 0.

I_{DD}

Positive supply current.

THEORY OF OPERATION

The ADG791A/ADG791G are monolithic CMOS devices comprising four 2:1 multiplexers controllable via a standard I²C serial interface. The CMOS process provides ultralow power dissipation, yet offers high switching speed and low on resistance.

The on resistance profile is very flat over the full analog input range, and wide bandwidth ensures excellent linearity and low distortion. These features, combined with a wide input signal range, make the ADG791A/ADG791G an ideal switching solution for a wide range of TV applications.

The switches conduct equally well in both directions when on. In the off condition, signal levels up to the supplies are blocked. The integrated serial I²C interface controls the operation of the switches (ADG791A/ADG791G) and general-purpose logic pins (ADG791G only).

The ADG791A/ADG791G have many attractive features, such as the ability to individually control each multiplexer, the option of reading back the status of any switch. The ADG791G has one general-purpose logic output pin controllable through the I²C interface. The following sections describe these features in detail.

I²C SERIAL INTERFACE

The ADG791A/ADG791G are controlled via an I²C-compatible serial bus interface (refer to the *I²C-Bus Specification* available from Philips Semiconductor) that allows the part to operate as a slave device (no clock is generated by the ADG791A/ADG791G). The communication protocol between the I²C master and the device operates as follows:

1. The master initiates data transfer by establishing a start condition (defined as a high-to-low transition on the SDA line while SCL is high). This indicates that an address/data stream follows. All slave devices connected to the bus respond to the start condition and shift in the next eight bits, consisting of a 7-bit address (MSB first) plus an R/W bit. This bit determines the direction of the data flow during the communication between the master and the addressed slave device.
2. The slave device whose address corresponds to the transmitted address responds by pulling the SDA line low during the ninth clock pulse (this is known as the acknowledge bit).

At this stage, all other devices on the bus remain idle while the selected device waits for data to be written to, or read from, its serial register. If the R/W bit is set high, the master reads from the slave device. However, if the R/W bit is set low, the master writes to the slave device.

3. Data transmits over the serial bus in sequences of nine clock pulses (eight data bits followed by an acknowledge bit). The transitions on the SDA line must occur during the low period of the clock signal, SCL, and remain stable during the high period of SCL. Otherwise, a low-to-high transition when the clock signal is high can be interpreted as a stop event that ends the communication between the master and the addressed slave device.
4. After transferring all data bytes, the master establishes a stop condition, defined as a low-to-high transition on the SDA line while SCL is high. In write mode, the master pulls the SDA line high during the 10th clock pulse to establish a stop condition. In read mode, the master issues a no acknowledge for the ninth clock pulse (the SDA line remains high). The master then brings the SDA line low before the 10th clock pulse, and then high during the 10th clock pulse to establish a stop condition.

I²C ADDRESS

The ADG791A/ADG791G has a 7-bit I²C address. The four most significant bits are internally hardwired while the last three bits (A0, A1, and A2) are user-adjustable. This allows the user to connect up to eight ADG791As/ADG791Gs to the same bus. The I²C bit map shows the configuration of the address.

7-Bit I²C Address Configuration

| MSB | | | | LSB | | |
|-----|---|---|---|-----|----|----|
| 1 | 0 | 1 | 0 | A2 | A1 | A0 |

WRITE OPERATION

When writing to the ADG791A/ADG791G, the user must begin with an address byte and R/W bit, after which time the switch acknowledges that it is prepared to receive data by pulling SDA low. Data is loaded into the device as a 16-bit word under the control of a serial clock input, SCL. Figure 31 illustrates the entire write sequence for the ADG791A/ADG791G. The first data byte (AX7 to AX0) controls the status of the switches while the LDSW and RESETB bits from the second byte control the operation mode of the device.

Table 6 shows a list of all commands supported by the ADG791A/ADG791G with the corresponding byte that needs to be loaded during a write operation.

To achieve the desired configuration, one or more commands can be loaded into the device. Any combination of the commands listed in Table 6 can be used with these restrictions:

- Only one switch from a given multiplexer can be ON at any given time
- When a sequence of successive commands affect the same element (that is, the switch or GPO pin), only the last command is executed.

ADG791A/ADG791G

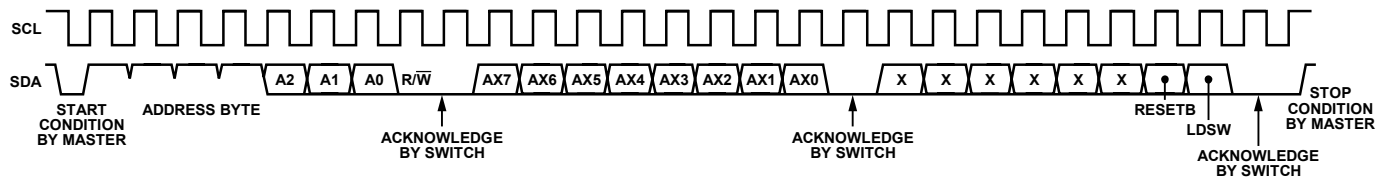


Figure 31. Write Operation

Table 6. ADG791A/ADG791G Command List

| AX7 | AX6 | AX5 | AX4 | AX3 | AX2 | AX1 | AX0 | Addressed Switch |
|----------------|-----|-----|-----|-----|-----|-----|-----|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | S1A/D1, S2A/D2, S3A/D3, S4A/D4 off |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | S1A/D1, S2A/D2, S3A/D3, S4A/D4 on |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | S1B/D1, S2B/D2, S3B/D3, S4B/D4 off |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | S1B/D1, S2B/D2, S3B/D3, S4B/D4 on |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | S1A/D1 off |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | S1A/D1 on |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | S1B/D1 off |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | S1B/D1 on |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | S2A/D2 off |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | S2A/D2 on |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | S2B/D2 off |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | S2B/D2 on |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | S3A/D3 off |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | S3A/D3 on |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | S3B/D3 off |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | S3B/D3 on |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | S4A/D4 off |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | S4A/D4 on |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | S4B/D4 off |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | S4B/D4 on |
| X ¹ | 0 | 0 | 0 | 1 | 0 | 1 | 0 | Reserved |
| X ¹ | 0 | 0 | 0 | 1 | 0 | 1 | 1 | Reserved |
| X ¹ | 0 | 0 | 0 | 1 | 1 | 0 | 0 | Reserved |
| X ¹ | 0 | 0 | 0 | 1 | 1 | 0 | 1 | Reserved |
| X ¹ | 0 | 0 | 0 | 1 | 1 | 1 | 0 | Mux 1 disabled (all switches connected to D1 are off) |
| X ¹ | 0 | 0 | 0 | 1 | 1 | 1 | 1 | Mux 2 disabled (all switches connected to D2 are off) |
| X ¹ | 0 | 0 | 1 | 0 | 0 | 0 | 0 | Mux 3 disabled (all switches connected to D3 are off) |
| X ¹ | 0 | 0 | 1 | 0 | 0 | 0 | 1 | Mux 4 disabled (all switches connected to D4 are off) |
| X ¹ | 0 | 0 | 1 | 0 | 0 | 1 | 0 | Reserved |
| X ¹ | 0 | 0 | 1 | 0 | 0 | 1 | 1 | Reserved |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | GPO1 high for ADG791G/reserved for ADG791A |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | GPO1 low for ADG791G/reserved for ADG791A |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | All muxes disabled |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | Reserved |

¹ X = Logic state does not matter.

LDSW BIT

The LDSW bit allows the user to control the way the device executes the commands loaded during the write operations. The ADG791A/ADG791G executes all the commands loaded between two successive write operations that have set the LDSW bit high.

Setting the LDSW high for every write cycle ensures that the device executes the command right after the LDSW bit was loaded into the device. This setting can be used when the desired configuration can be achieved by sending a single command or when the switches and/or GPO pin are not required to be updated at the same time. When the desired configuration requires multiple commands with simultaneous update, the LDSW bit should be set low while loading the commands except the last one when the LDSW bit should be set high. Once the last command with LDSW = high is loaded, the device executes all commands received since the last update simultaneously.

POWER ON/SOFTWARE RESET

The ADG791A/ADG791G has a software reset function implemented by the RESETB bit from the second data byte written to the device. For normal operation of the multiplexers and GPO pin, this bit should be set high. When RESETB = low or after power-up, the switches from all multiplexers are turned off (open) and the GPO pin is set low.

READ OPERATION

When reading data back from the ADG791A/ADG791G, the user must begin with an address byte and R/ \overline{W} bit. The switch then acknowledges that it is prepared to transmit data by pulling SDA low. Following this acknowledgement, the ADG791A/ADG791G transmits two bytes on the next clock edges. These bytes contain the status of the switches, and each byte is followed by an acknowledge bit. A logic high bit represents a switch in the on (close) state while a low represents a switch in the off (open) state. For the GPO pin (ADG791G only), the bit represents the logic value of the pin. Figure 32 illustrates the entire read sequence.

The bit maps accompanying Figure 32 show the relationship between the elements of the ADG791A and ADG791G (that is, the switches and GPO pins) and the bits that represent their status after a completed read operation.

ADG791A Bit Map

| RB15 | RB14 | RB13 | RB12 | RB11 | RB10 | RB9 | RB8 | RB7 | RB6 | RB5 | RB4 | RB3 | RB2 | RB1 | RB0 |
|--------|--------|--------|--------|--------|--------|--------|--------|-----|-----|-----|-----|-----|-----|-----|-----|
| S1A/D1 | S1B/D1 | S2A/D2 | S2B/D2 | S3A/D3 | S3B/D3 | S4A/D4 | S4B/D4 | - | - | - | - | - | - | - | - |

ADG791G Bit Map

| RB15 | RB14 | RB13 | RB12 | RB11 | RB10 | RB9 | RB8 | RB7 | RB6 | RB5 | RB4 | RB3 | RB2 | RB1 | RB0 |
|--------|--------|--------|--------|--------|--------|--------|--------|-----|-----|-----|-----|------|-----|-----|-----|
| S1A/D1 | S1B/D1 | S2A/D2 | S2B/D2 | S3A/D3 | S3B/D3 | S4A/D4 | S4B/D4 | - | - | - | - | GPO1 | - | - | - |

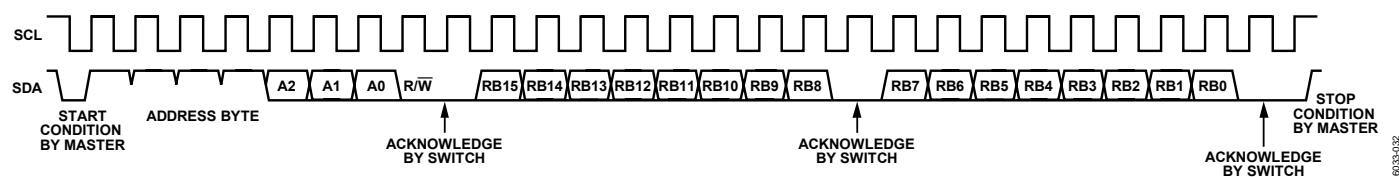


Figure 32. ADG791A/ADG791G Read Operation

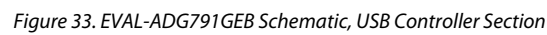
EVALUATION BOARD

The ADG791G evaluation kit allows designers to evaluate the high performance of the device with a minimum of effort.

The evaluation kit includes a printed circuit board populated with the ADG791G. The evaluation board can be used to evaluate the performance of both the ADG791A and ADG791G. It interfaces to the USB port of a PC, or it can be used as a standalone evaluation board. Software is available with the evaluation board that allows the user to easily program the ADG791G through the USB port. Schematics of the evaluation board are shown in Figure 33 and Figure 34. The software runs on any PC that has Microsoft® Windows® 2000 or Windows XP installed.

USING THE ADG791G EVALUATION BOARD

The ADG791G evaluation kit is a test system designed to simplify the evaluation of the device. Each input/output of the part comes with a socket specifically chosen for easy audio/video evaluation. A data sheet is also available and gives full information on operating the evaluation board.



ADG791A/ADG791G

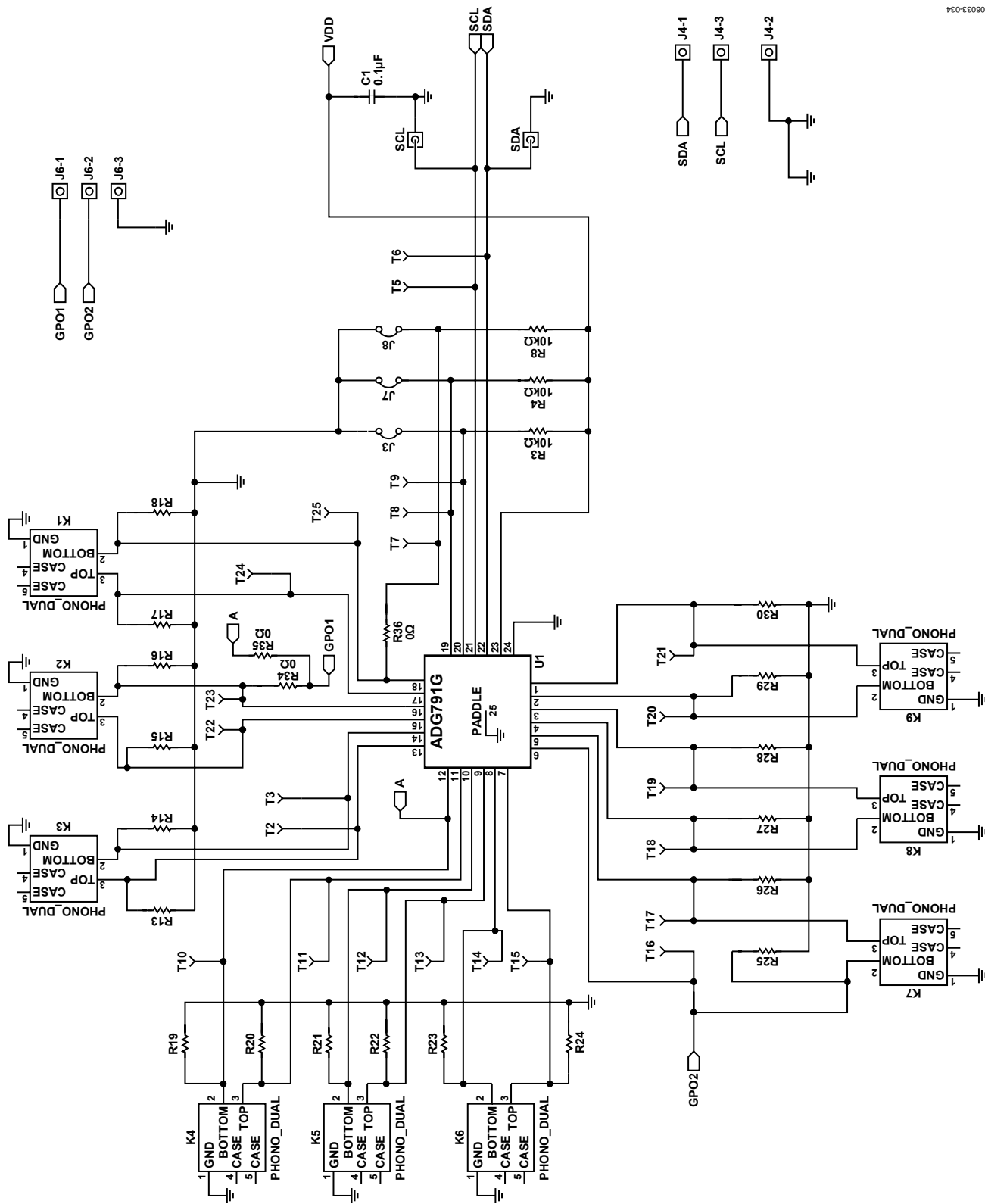
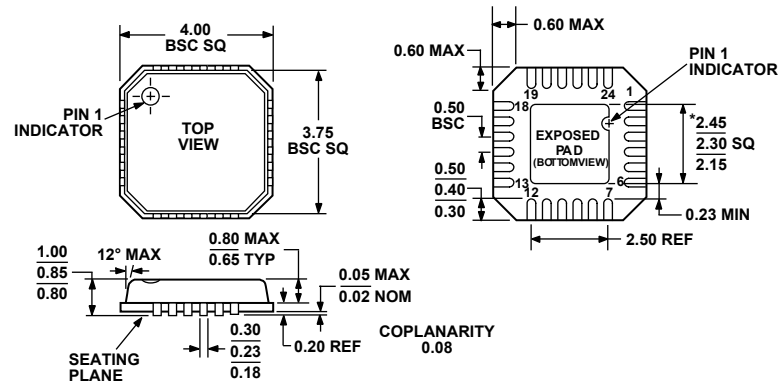


Figure 34. EVAL-ADG791GEB Schematic, Chip Section

OUTLINE DIMENSIONS



*COMPLIANT TO JEDEC STANDARDS MO-220-VGGD-2
EXCEPT FOR EXPOSED PAD DIMENSION

Figure 35. 24-Lead Lead Frame Chip Scale Package [LFCSP_VQ]
4 mm x 4 mm Body, Very Thin Quad
(CP-24-2)
Dimensions shown in millimeters

ORDERING GUIDE

| Model | Temperature Range | I ² C Speed | Package Description | Package Option |
|---------------------------------|-------------------|---------------------------|---------------------|----------------|
| ADG791ABCPZ-REEL ¹ | −40°C to +85°C | 100 kHz, 400 kHz | 24-Lead LFCSP_VQ | CP-24-2 |
| ADG791ABCPZ-500RL7 ¹ | −40°C to +85°C | 100 kHz, 400 kHz | 24-Lead LFCSP_VQ | CP-24-2 |
| ADG791ACCPZ-REEL ¹ | −40°C to +85°C | 100 kHz, 400 kHz, 3.4 MHz | 24-Lead LFCSP_VQ | CP-24-2 |
| ADG791ACCPZ-500RL7 ¹ | −40°C to +85°C | 100 kHz, 400 kHz, 3.4 MHz | 24-Lead LFCSP_VQ | CP-24-2 |
| ADG791GBCPZ-REEL ¹ | −40°C to +85°C | 100 kHz, 400 kHz | 24-Lead LFCSP_VQ | CP-24-2 |
| ADG791GBCPZ-500RL7 ¹ | −40°C to +85°C | 100 kHz, 400 kHz | 24-Lead LFCSP_VQ | CP-24-2 |
| ADG791GCCPZ-REEL ¹ | −40°C to +85°C | 100 kHz, 400 kHz, 3.4 MHz | 24-Lead LFCSP_VQ | CP-24-2 |
| ADG791GCCPZ-500RL7 ¹ | −40°C to +85°C | 100 kHz, 400 kHz, 3.4 MHz | 24-Lead LFCSP_VQ | CP-24-2 |
| EVAL-ADG791GEB ² | | | Evaluation Board | |

¹ Z = Pb-free part.

² Evaluation board is RoHS compliant.

NOTES

Purchase of licensed I²C components of Analog Devices or one of its sublicensed Associated Companies conveys a license for the purchaser under the Philips I²C Patent Rights to use these components in an I²C system, provided that the system conforms to the I²C Standard Specification as defined by Philips.