# CMOS Low Voltage 2.5 Ω Dual SPDT Switch

Data Sheet

# ADG736

## FEATURES

- 1.8 V to 5.5 V single supply
- Automotive temperature range: −40°C to +125°C
- 2.5 Ω (typical) on resistance
- Low on resistance flatness
- −3 dB bandwidth > 200 MHz
- Rail-to-rail operation
- 10-lead MSOP package
- Fast switching times
  - $t_{ON}$: 16 ns
  - $t_{OFF}$: 8 ns
- Typical power consumption (<0.01 µW)
- TTL-/CMOS-compatible
- Qualified for automotive applications

## APPLICATIONS

- USB 1.1 signal switching circuits
- Cell phones
- PDAs
- Battery-powered systems
- Communications systems
- Sample-and-hold systems
- Audio signal routing
- Audio and video switching
- Mechanical reed relay replacement

## FUNCTIONAL BLOCK DIAGRAM

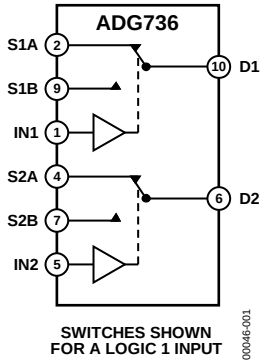


*Figure 1.*

## GENERAL DESCRIPTION

The ADG736 is a monolithic device comprising two independently selectable CMOS single pole, double throw (SPDT) switches. These switches are designed using a submicron process that provides low power dissipation yet gives high switching speed, low on resistance, low leakage currents, and wide input signal bandwidth.

The on resistance profile is very flat over the full analog signal range. This ensures excellent linearity and low distortion when switching audio signals. Fast switching speed also makes the part suitable for video signal switching.

The ADG736 operates from a single 1.8 V to 5.5 V supply, making it ideally suited to portable and battery-powered instruments.

Each switch conducts equally well in both directions when on, and each has an input signal range that extends to the power supplies. The ADG736 exhibits break-before-make switching action.

The ADG736 is available in a 10-lead MSOP package.

## PRODUCT HIGHLIGHTS

1. 1.8 V to 5.5 V Single-Supply Operation. The ADG736 offers high performance, including low on resistance and fast switching times. It is fully specified and guaranteed with 3 V and 5 V supply rails.
2. Very Low $R_{ON}$ (4.5 Ω Maximum at 5 V, 8 Ω Maximum at 3 V). At a supply voltage of 1.8 V, $R_{ON}$ is typically 35 Ω over the temperature range.
3. Low On Resistance Flatness.
4. −3 dB Bandwidth > 200 MHz.
5. Low Power Dissipation. CMOS construction ensures low power dissipation.
6. Fast $t_{ON}/t_{OFF}$.
7. Break-Before-Make Switching Action.
8. 10-Lead MSOP Package.

**Rev. D**


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# ADG736* PRODUCT PAGE QUICK LINKS

Last Content Update: 02/23/2017

## COMPARABLE PARTS

View a parametric search of comparable parts.

## EVALUATION KITS

- Evaluation Board for 10-Lead MSOP Devices in the Switches and Multiplexers Portfolio

## DOCUMENTATION

**Data Sheet**

- ADG736: CMOS Low Voltage 2.5 Ω Dual SPDT Switch Data Sheet

**User Guides**

- UG-1037: Evaluation Board for 10-Lead MSOP Devices in the Switches and Multiplexers Portfolio

## REFERENCE MATERIALS

**Product Selection Guide**

- Switches and Multiplexers Product Selection Guide

**Technical Articles**

- CMOS Switches Offer High Performance in Low Power, Wideband Applications
- Data-acquisition system uses fault protection
- Enhanced Multiplexing for MEMS Optical Cross Connects
- Temperature monitor measures three thermal zones

## DESIGN RESOURCES

- ADG736 Material Declaration
- PCN-PDN Information
- Quality And Reliability
- Symbols and Footprints

## DISCUSSIONS

View all ADG736 EngineerZone Discussions.

## SAMPLE AND BUY

Visit the product page to see pricing options.

## TECHNICAL SUPPORT

Submit a technical question or find your regional support number.

## DOCUMENT FEEDBACK

Submit feedback for this data sheet.

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**1/07—Rev. A to Rev. B**

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# SPECIFICATIONS

$V_{DD}$ = 5 V ± 10%, GND = 0 V. All specifications −40°C to +125°C, unless otherwise noted.

**Table 1.**

| Parameter | B Version | | | Unit | Test Conditions/Comments |
|---|---|---|---|---|---|
| | 25°C | −40°C to +85°C | −40°C to +125°C | | |
| ANALOG SWITCH | | | | | |
| Analog Signal Range | | | 0 V to $V_{DD}$ | V | |
| On Resistance ($R_{ON}$) | 2.5 | | | Ω typ | $V_S$ = 0 V to $V_{DD}$, $I_{DS}$ = −10 mA; see Figure 10 |
| | 4 | 4.5 | 7 | Ω max | |
| On Resistance Match Between Channels ($\Delta R_{ON}$) | 0.1 | | | Ω typ | $V_S$ = 0 V to $V_{DD}$, $I_{DS}$ = −10 mA |
| | | 0.4 | 0.4 | Ω max | |
| On Resistance Flatness ($R_{FLAT (ON)}$) | 0.5 | | | Ω typ | $V_S$ = 0 V to $V_{DD}$, $I_{DS}$ = −10 mA |
| | | 1.2 | 1.5 | Ω max | |
| LEAKAGE CURRENTS | | | | | $V_{DD}$ = 5.5 V |
| Source Off Leakage $I_S$ (Off) | ±0.01 | | 1 | nA typ | $V_S$ = 4.5 V/1 V, $V_D$ = 1 V/4.5 V; see Figure 11 |
| Channel On Leakage $I_D$, $I_S$ (On) | ±0.01 | | 5 | nA typ | $V_S$ = $V_D$ = 1 V or 4.5 V; see Figure 12 |
| DIGITAL INPUTS | | | | | |
| Input High Voltage, $V_{INH}$ | | 2.4 | 2.4 | V min | |
| Input Low Voltage, $V_{INL}$ | | 0.8 | 0.8 | V max | |
| Input Current, $I_{INL}$ or $I_{INH}$ | 0.005 | | | μA typ | $V_{IN}$ = $V_{INL}$ or $V_{INH}$ |
| | | ± 0.1 | ± 0.1 | μA max | |
| DYNAMIC CHARACTERISTICS[1] | | | | | |
| $t_{ON}$ | 12 | | | ns typ | $R_L$ = 300 Ω, $C_L$ = 35 pF |
| | | 16 | 16 | ns max | $V_S$ = 3 V; see Figure 13 |
| $t_{OFF}$ | 5 | | | ns typ | $R_L$ = 300 Ω, $C_L$ = 35 pF |
| | | 8 | 8 | ns max | $V_S$ = 3 V; see Figure 13 |
| Break-Before-Make Time Delay, $t_D$ | 7 | | | ns typ | $R_L$ = 300 Ω, $C_L$ = 35 pF |
| | | 1 | 1 | ns min | $V_{S1}$ = $V_{S2}$ = 3 V; see Figure 14 |
| Off Isolation | −62 | | | dB typ | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 10 MHz |
| | −82 | | | dB typ | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 1 MHz; see Figure 15 |
| Channel-to-Channel Crosstalk | −62 | | | dB typ | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 10 MHz |
| | −82 | | | dB typ | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 1 MHz; see Figure 16 |
| Bandwidth (−3 dB) | 200 | | | MHz typ | $R_L$ = 50 Ω, $C_L$ = 5 pF; see Figure 17 |
| $C_S$ (Off) | 9 | | | pF typ | |
| $C_D$, $C_S$ (On) | 32 | | | pF typ | |
| POWER REQUIREMENTS | | | | | $V_{DD}$ = 5.5 V |
| $I_{DD}$ | 0.001 | | | μA typ | Digital inputs = 0 V or 5 V |
| | | 1.0 | 1.0 | μA max | |

[1] Guaranteed by design; not subject to production test.

$V_{DD}$ = 3 V ± 10%, GND = 0 V. All specifications −40°C to +125°C, unless otherwise noted.

**Table 2.**

| Parameter | B Version | | | Unit | Test Conditions/Comments |
|---|---|---|---|---|---|
| | 25°C | −40°C to +85°C | −40°C to +125°C | | |
| ANALOG SWITCH | | | | | |
| Analog Signal Range | | | 0 V to $V_{DD}$ | V | |
| On Resistance ($R_{ON}$) | 5 | 5.5 | | Ω typ | $V_S$ = 0 V to $V_{DD}$, $I_{DS}$ = −10 mA; see Figure 10 |
| | | 8 | 12 | Ω max | See Figure 10 |
| On Resistance Match Between Channels ($\Delta R_{ON}$) | 0.1 | | | Ω typ | $V_S$ = 0 V to $V_{DD}$, $I_{DS}$ = −10 mA |
| | | 0.4 | 0.4 | Ω max | |
| On Resistance Flatness ($R_{FLAT (ON)}$) | | 2.5 | 2.5 | Ω typ | $V_S$ = 0 V to $V_{DD}$, $I_{DS}$ = −10 mA |
| LEAKAGE CURRENTS | | | | | $V_{DD}$ = 3.3 V |
| Source Off Leakage $I_S$ (Off) | ±0.01 | | 1 | nA typ | $V_S$ = 3 V/1 V, $V_D$ = 1 V/3 V; see Figure 11 |
| Channel On Leakage $I_D$, $I_S$ (On) | ±0.01 | | 5 | nA typ | $V_S$ = $V_D$ = 1 V or 3 V; see Figure 12 |
| DIGITAL INPUTS | | | | | |
| Input High Voltage, $V_{INH}$ | | 2.0 | 2.4 | V min | |
| Input Low Voltage, $V_{INL}$ | | 0.4 | 0.8 | V max | |
| Input Current, $I_{INL}$ or $I_{INH}$ | 0.005 | | | μA typ | $V_{IN}$ = $V_{INL}$ or $V_{INH}$ |
| | | ±0.1 | ± 0.1 | μA max | |
| DYNAMIC CHARACTERISTICS[1] | | | | | |
| $t_{ON}$ | 14 | | | ns typ | $R_L$ = 300 Ω, $C_L$ = 35 pF |
| | | 20 | 20 | ns max | $V_S$ = 2 V; see Figure 13 |
| $t_{OFF}$ | 6 | | | ns typ | $R_L$ = 300 Ω, $C_L$ = 35 pF |
| | | 10 | 10 | ns max | $V_S$ = 2 V; see Figure 13 |
| Break-Before-Make Time Delay, $t_D$ | 7 | | | ns typ | $R_L$ = 300 Ω, $C_L$ = 35 pF |
| | | 1 | 1 | ns min | $V_{S1}$ = $V_{S2}$ = 2 V; see Figure 14 |
| Off Isolation | −62 | | | dB typ | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 10 MHz |
| | −82 | | | dB typ | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 1 MHz; see Figure 15 |
| Channel-to-Channel Crosstalk | −62 | | | dB typ | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 10 MHz |
| | −82 | | | dB typ | $R_L$ = 50 Ω, $C_L$ = 5 pF, f = 1 MHz; see Figure 16 |
| Bandwidth (−3 dB) | 200 | | | MHz typ | $R_L$ = 50 Ω, $C_L$ = 5 pF; see Figure 17 |
| $C_S$ (Off) | 9 | | | pF typ | |
| $C_D$, $C_S$ (On) | 32 | | | pF typ | |
| POWER REQUIREMENTS | | | | | $V_{DD}$ = 3.3 V |
| $I_{DD}$ | 0.001 | | | μA typ | Digital inputs = 0 V or 3 V |
| | | 1.0 | 1.0 | μA max | |

[1] Guaranteed by design; not subject to production test.

# ABSOLUTE MAXIMUM RATINGS

$T_A$ = 25°C, unless otherwise noted.

**Table 3.**

| Parameter | Rating |
|---|---|
| $V_{DD}$ to GND | −0.3 V to +6 V |
| Analog, Digital Inputs[1] | −0.3 V to $V_{DD}$ + 0.3 V or 30 mA, whichever occurs first |
| Continuous Current, S or D | 30 mA |
| Peak Current, S or D | 100 mA (Pulsed at 1 ms, 10% duty cycle maximum) |
| Operating Temperature Range | |
| Automotive | −40°C to +125°C |
| Storage Temperature Range | −65°C to +150°C |
| Junction Temperature | 150°C |
| MSOP Package, Power Dissipation | 315 mW |
| $\theta_{JA}$ Thermal Impedance | 205°C/W |
| Lead Temperature (Soldering, 10 sec) | 300°C |
| IR Reflow (Peak Temperature, <20 sec) | 235°C |
| Lead-Free Reflow Soldering | |
| Peak Temperature | 260(+0/−5)°C |
| Time at Peak Temperature | 10 sec to 40 sec |
| ESD | 2 kV |

[1] Overvoltages at IN, S, or D are clamped by internal diodes. Current should be limited to the maximum ratings given.

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.

# PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

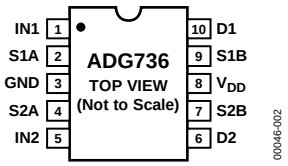



*Figure 2. Pin Configuration*

**Table 4. Pin Function Descriptions**

| Pin No. | Mnemonic | Description |
|---|---|---|
| 1 | IN1 | Logic Control Input. |
| 2 | S1A | Source Terminal. May be an input or output. |
| 3 | GND | Ground (0 V) Reference. |
| 4 | S2A | Source Terminal. May be an input or output. |
| 5 | IN2 | Logic Control Input. |
| 6 | D2 | Drain Terminal. May be an input or output. |
| 7 | S2B | Source Terminal. May be an input or output. |
| 8 | $V_{DD}$ | Most Positive Power Supply Potential. |
| 9 | S1B | Source Terminal. May be an input or output. |
| 10 | D1 | Drain Terminal. May be an input or output. |

**Table 5. Truth Table**

| Logic | Switch A | Switch B |
|---|---|---|
| 0 | Off | On |
| 1 | On | Off |

# TYPICAL PERFORMANCE CHARACTERISTICS

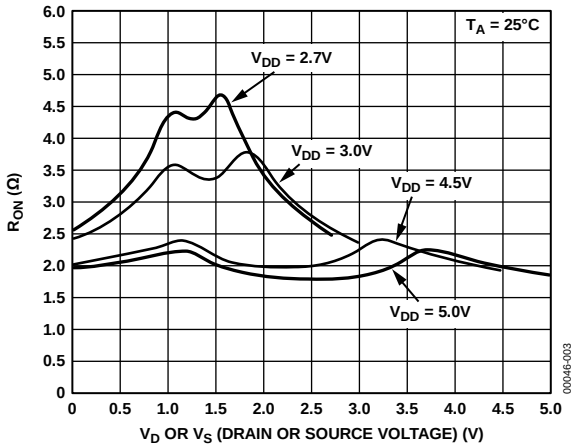



*Figure 3. On Resistance as a Function of $V_D$ or $V_S$ Single Supplies*

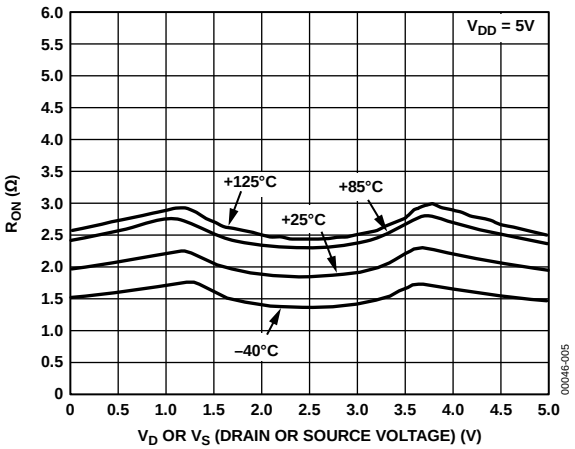



*Figure 5. On Resistance as a Function of $V_D$ or $V_S$ for Different Temperatures $V_{DD}$ = 5 V*

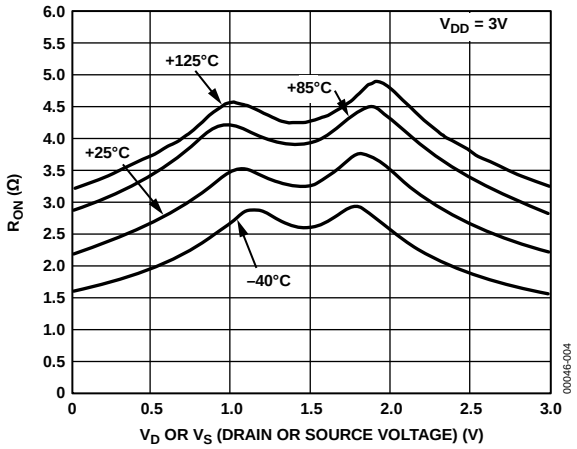



*Figure 4. On Resistance as a Function of $V_D$ or $V_S$ for Different Temperatures $V_{DD}$ = 3 V*

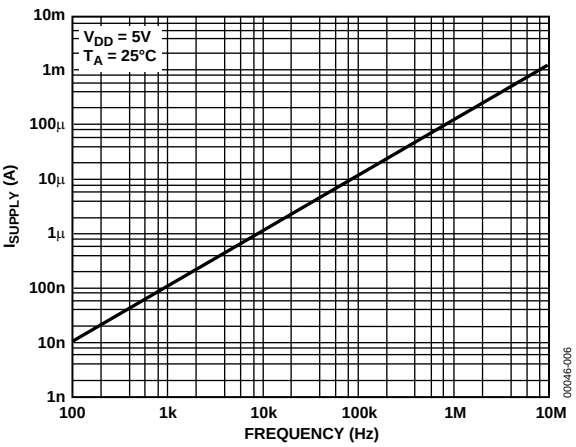



*Figure 6. Supply Current vs. Input Switching Frequency*

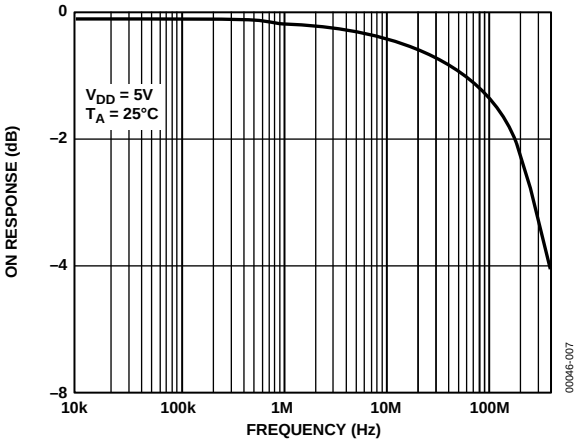



Figure 7. Bandwidth

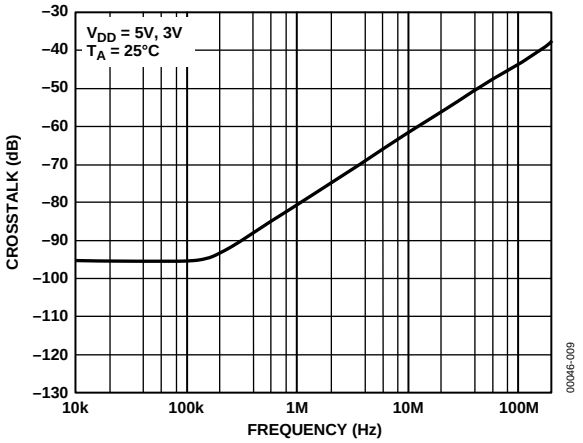



Figure 9. Crosstalk vs. Frequency

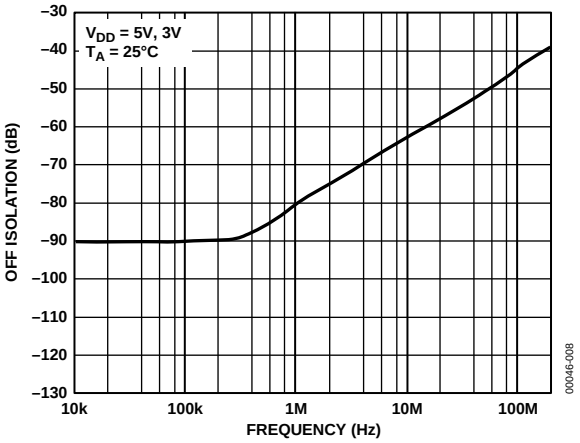



Figure 8. Off Isolation vs. Frequency

# TEST CIRCUITS

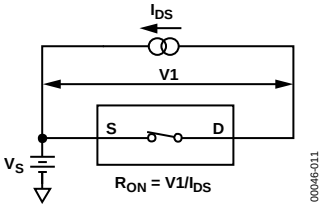



Figure 10. On Resistance

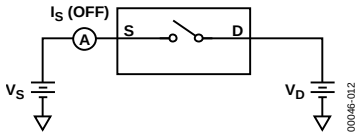



Figure 11. Off Leakage

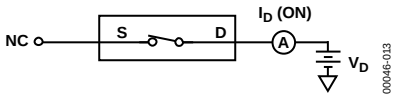



Figure 12. On Leakage

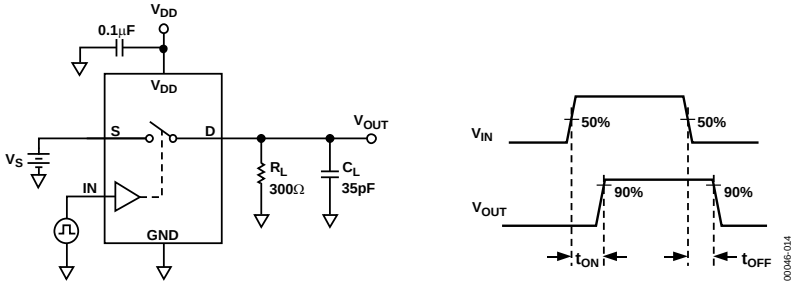



Figure 13. Switching Times

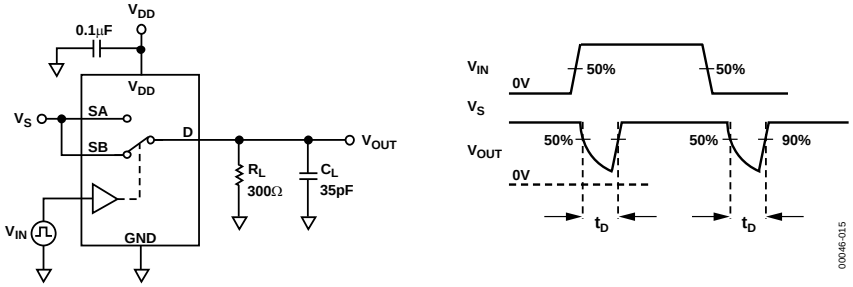



Figure 14. Break-Before-Make Time Delay, $t_D$

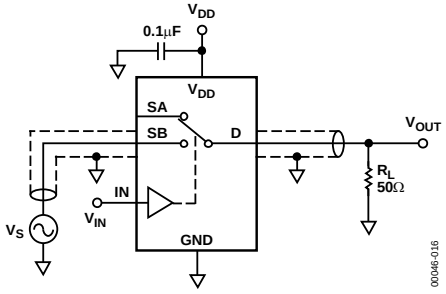



Figure 15. Off Isolation

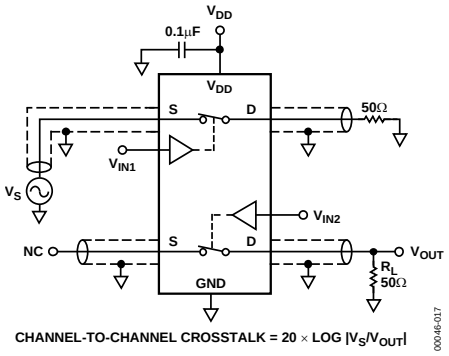



Figure 16. Channel-to-Channel Crosstalk

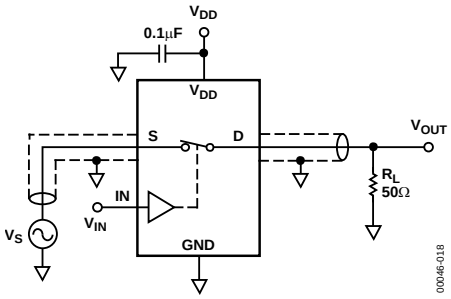



Figure 17. Bandwidth

# TERMINOLOGY

**$R_{ON}$**
Ohmic resistance between Terminal D and Terminal S.

**$\Delta R_{ON}$**
On resistance match between any two channels; that is, $R_{ON}$ maximum − $R_{ON}$ minimum.

**$R_{FLAT (ON)}$**
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.

**$I_D$, $I_S$ (On)**
Channel leakage current with the switch on.

**$V_D$ ($V_S$)**
Analog voltage on Terminal D and Terminal S.

**$C_S$ (Off)**
Off switch source capacitance.

**$C_D$, $C_S$ (On)**
On switch capacitance.

**$t_{ON}$**
Delay between applying the digital control input and the output switching on. See Figure 13.

**$t_{OFF}$**
Delay between applying the digital control input and the output switching off. See Figure 13.

**$t_D$**
Off time or on time measured between the 90% points of both switches, when switching from one address state to another. See Figure 14.

**Crosstalk**
A measure of unwanted signal that is coupled from one channel to another as a result of parasitic capacitance.

**Off Isolation**
A measure of unwanted signal coupling through an off switch.

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

**On Response**
The frequency response of the on switch.

**On Loss**
The voltage drop across the on switch, seen on the on response vs. frequency plot (see Figure 7) as how many decibels (dB) the signal is away from 0 dB at very low frequencies.

# APPLICATIONS INFORMATION

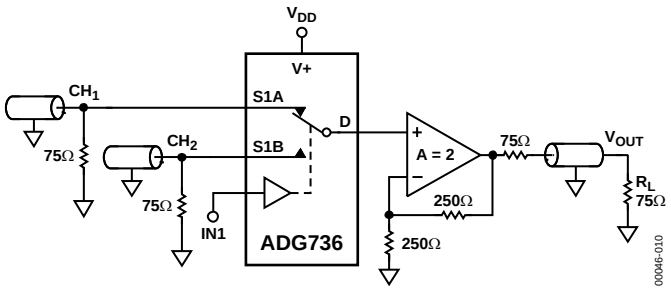
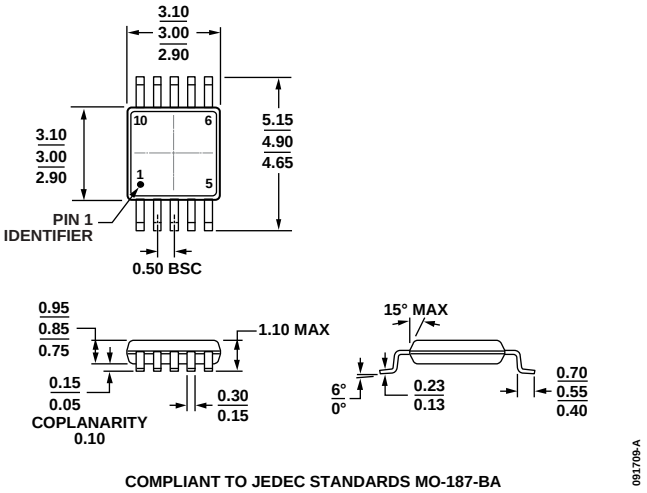



*Figure 18. Using the ADG736 to Select Between Two Video Signals*

# OUTLINE DIMENSIONS




COMPLIANT TO JEDEC STANDARDS MO-187-BA

*Figure 19. 10-Lead Mini Small Outline Package [MSOP]*
*(RM-10)*
*Dimensions shown in millimeters*

## ORDERING GUIDE

| Model[1, 2] | Temperature Range | Package Description | Package Option | Branding |
|---|---|---|---|---|
| ADG736BRM | −40°C to +125°C | 10-Lead Mini Small Outline Package (MSOP) | RM-10 | SAB |
| ADG736BRM-REEL | −40°C to +125°C | 10-Lead Mini Small Outline Package (MSOP) | RM-10 | SAB |
| ADG736BRM-REEL7 | −40°C to +125°C | 10-Lead Mini Small Outline Package (MSOP) | RM-10 | SAB |
| ADG736BRMZ | −40°C to +125°C | 10-Lead Mini Small Outline Package (MSOP) | RM-10 | SAB# |
| ADG736BRMZ-REEL | −40°C to +125°C | 10-Lead Mini Small Outline Package (MSOP) | RM-10 | SAB# |
| ADG736BRMZ-REEL7 | −40°C to +125°C | 10-Lead Mini Small Outline Package (MSOP) | RM-10 | SAB# |
| ADW54010Z-0REEL | −40°C to +125°C | 10-Lead Mini Small Outline Package (MSOP) | RM-10 | SAB# |

[1] Z = RoHS Compliant Part, # denotes RoHS compliant part may be top or bottom marked.
[2] W = Qualified for Automotive Applications.

## AUTOMOTIVE PRODUCTS

The ADW54010Z model is available with controlled manufacturing to support the quality and reliability requirements of automotive applications. Note that these automotive models may have specifications that differ from the commercial models; therefore, designers should review the Specifications section of this data sheet carefully. Only the automotive grade products shown are available for use in automotive applications. Contact your local Analog Devices account representative for specific product ordering information and to obtain the specific Automotive Reliability reports for these models.