



# Wideband, 38 dB Isolation at 1 GHz, CMOS 1.65 V to 2.75 V, SPST Switch

Enhanced Product

**ADG901-EP**

## FEATURES

Wideband switch:  $-3$  dB at 4.5 GHz  
Absorptive switch  
High off isolation: 38 dB at 1 GHz  
Low insertion loss: 0.8 dB at 1 GHz  
Single 1.65 V to 2.75 V power supply  
CMOS/LVTTL control logic  
Tiny 3 mm  $\times$  3 mm LFCSP package  
Low power consumption ( $<2.5$   $\mu$ A)

## ENHANCED PRODUCT FEATURES

Supports defense and aerospace applications (AQEC standard)  
Military temperature range:  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$   
Controlled manufacturing baseline  
1 assembly/test site  
1 fabrication site  
Enhanced product change notification  
Qualification data available on request

## APPLICATIONS

Wireless communications  
General-purpose radio frequency (RF) switching  
Dual-band applications  
High speed filter selection  
Digital transceiver front-end switch  
IF switching  
Tuner modules  
Antenna diversity switching list

## GENERAL DESCRIPTION

The **ADG901-EP** is a wideband switch that uses a CMOS process to provide high isolation and low insertion loss to 1 GHz. The **ADG901-EP** is an absorptive (matched) switch with 50  $\Omega$  terminated shunt legs. This switch is designed such that the isolation is high over the dc to 1 GHz frequency range. The **ADG901-EP** has on-board CMOS control logic, thus eliminating the need for external controlling circuitry. The control inputs are both CMOS and LVTTL compatible. The low power consumption of this CMOS device makes it ideally suited to wireless applications and general-purpose high frequency switching.

Additional application and technical information can be found in the **ADG901** data sheet.

## FUNCTIONAL BLOCK DIAGRAM

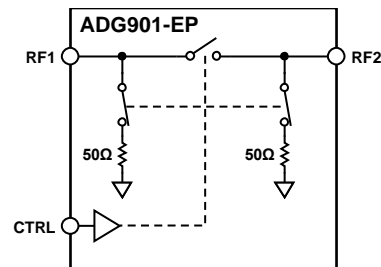


Figure 1.

## PRODUCT HIGHLIGHTS

1.  $-38$  dB Off Isolation at 1 GHz
2. 0.8 dB Insertion Loss at 1 GHz
3. Tiny 8-Lead LFCSP Package

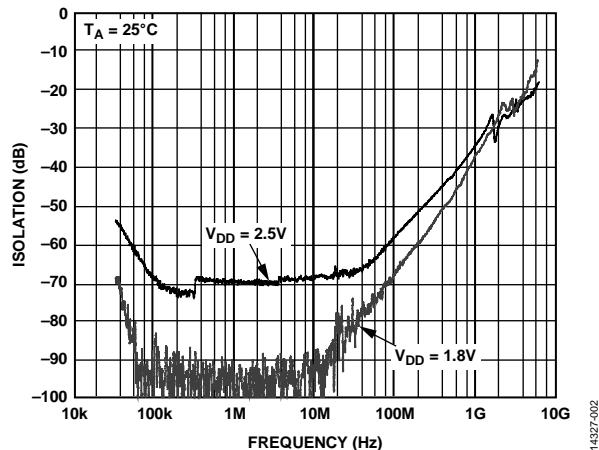


Figure 2. Off Isolation vs. Frequency

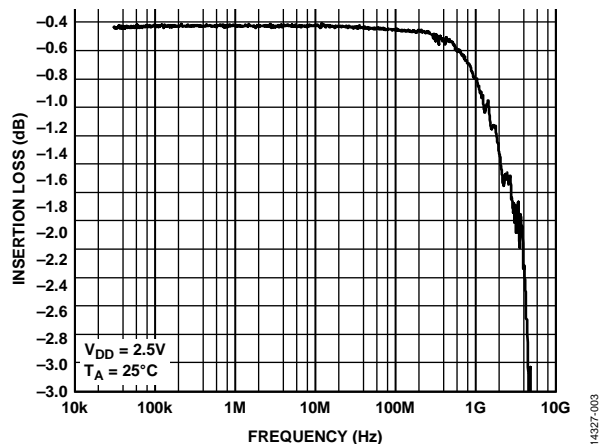


Figure 3. Insertion Loss vs. Frequency

Rev. A

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REVISION HISTORY

12/2016—Rev. 0 to Rev. A	
Change to Product Title.....	1

9/2016—Revision 0: Initial Version

## SPECIFICATIONS

$V_{DD} = 1.65\text{ V to }2.75\text{ V}$ ,  $GND = 0\text{ V}$ , input power = 0 dBm, temperature range =  $-55^{\circ}\text{C to }+125^{\circ}\text{C}$ , unless otherwise noted.

Table 1.

Parameter	Symbol	Test Conditions/Comments	Min	Typ <sup>1</sup>	Max	Unit
AC ELECTRICAL CHARACTERISTICS						
–3 dB Frequency <sup>2</sup>				4.5		GHz
Insertion Loss	$S_{21}, S_{12}$	DC to 100 MHz; $V_{DD} = 2.5\text{ V} \pm 10\%$ , see Figure 19		0.4	0.7	dB
		500 MHz; $V_{DD} = 2.5\text{ V} \pm 10\%$		0.6	1	dB
		1000 MHz; $V_{DD} = 2.5\text{ V} \pm 10\%$		0.8	1.25	dB
Isolation—RF1 to RF2	$S_{21}, S_{12}$	100 MHz	55	61		dB
		500 MHz	40	45		dB
		1000 MHz	31	38		dB
Return Loss (On Channel) <sup>2</sup>	$S_{11}, S_{22}$	DC to 100 MHz	18	28		dB
		500 MHz		25		dB
		1000 MHz		20		dB
Return Loss (Off Channel) <sup>2</sup>	$S_{11}, S_{22}$	DC to 100 MHz	15	23		dB
		500 MHz		21		dB
		1000 MHz		19		dB
On Switching Time <sup>2</sup>	$t_{ON}$	50% CTRL to 90% RF, see Figure 16		4	6.5	ns
Off Switching Time <sup>2</sup>	$t_{OFF}$	50% CTRL to 10% RF, see Figure 16		6.5	10.5	ns
Rise Time <sup>2</sup>	$t_{RISE}$	10% to 90% RF, see Figure 17		3.1	5.5	ns
Fall Time <sup>2</sup>	$t_{FALL}$	90% to 10% RF, see Figure 17		6.0	9.5	ns
Third-Order Intermodulation Intercept	IP3	900 MHz/901 MHz, 4 dBm, see Figure 21	28.5	36		dBm
Video Feedthrough <sup>3</sup>		See Figure 20		2.5		mV p-p
INPUT POWER						
1 dB Input Compression <sup>4</sup>	P1dB	1000 MHz; see Figure 22		17		dBm
DC ELECTRICAL CHARACTERISTICS						
Input High Voltage	$V_{INH}$	$V_{DD} = 2.25\text{ V to }2.75\text{ V}$	1.7			V
	$V_{INH}$	$V_{DD} = 1.65\text{ V to }1.95\text{ V}$	0.65 $V_{DD}$			V
Input Low Voltage	$V_{INL}$	$V_{DD} = 2.25\text{ V to }2.75\text{ V}$			0.7	V
	$V_{INL}$	$V_{DD} = 1.65\text{ V to }1.95\text{ V}$			0.35 $V_{DD}$	V
Input Leakage Current	$I_I$	$0 \leq V_{IN} \leq 2.75\text{ V}$		$\pm 0.1$	$\pm 1$	$\mu\text{A}$
CAPACITANCE <sup>2</sup>						
RF1/RF2, RF Port On Capacitance	$C_{RF\text{ on}}$	$f = 1\text{ MHz}$		1.2		pF
CTRL Input Capacitance	$C_{CTRL}$	$f = 1\text{ MHz}$		2.1		pF
POWER REQUIREMENTS						
$V_{DD}$			1.65		2.75	V
Quiescent Power Supply Current	$I_{DD}$	Digital inputs = 0 V or $V_{DD}$		0.1	2.5	$\mu\text{A}$

<sup>1</sup> Typical values are at  $V_{DD} = 2.5\text{ V}$  and  $25^{\circ}\text{C}$ , unless otherwise specified.

<sup>2</sup> Guaranteed by design, not subject to production test.

<sup>3</sup> Video feedthrough is the dc transience at the output of any port of the switch when the control voltage is switched from high to low or low to high in a  $50\text{ }\Omega$  test setup, measured with 1 ns rise time pulses and 500 MHz bandwidth.

<sup>4</sup> For less than 100 MHz, refer to the [AN-952 Application Note](#) for more information about power handling.

## CONTINUOUS CURRENT PER CHANNEL

Table 2.

Parameter	25°C	85°C	105°C	125°C	Unit	Test Conditions/Comments
CONTINUOUS CURRENT PER CHANNEL <sup>1</sup>						8-lead LFCSP, $\theta_{JA} = 48^{\circ}\text{C/W}$ , dc bias = 0.5 V
$V_{DD} = 2.75\text{ V}, V_{SS} = 0\text{ V}$	70	7	3.85	2.8	mA maximum	
$V_{DD} = 1.65\text{ V}, V_{SS} = 0\text{ V}$	56	7	3.85	2.8	mA maximum	

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

## ABSOLUTE MAXIMUM RATINGS

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

Table 3.

Parameter	Rating
$V_{DD}$ to GND <sup>1</sup>	–0.5 V to +4 V
Inputs to GND <sup>1, 2</sup>	–0.5 V to $V_{DD} + 0.3$ V
Continuous Current	Data <sup>3</sup> + 15%
Input Power <sup>4</sup>	18 dBm
Operating Temperature Range (Industrial)	–55°C to +125°C
Storage Temperature Range	–65°C to +150°C
Junction Temperature	150°C
Lead Temperature, Soldering (10 sec)	300°C
IR Reflow, Peak Temperature (<20 sec)	235°C
ESD	1 kV

<sup>1</sup> Tested at 125°C.

<sup>2</sup> When RF1 and RF2 are in the open position, the input to ground rating is –0.5 V to  $V_{DD} - 0.5$  V.

<sup>3</sup> See Table 2.

<sup>4</sup> The switch is tested in both the open and closed positions. In the closed condition, power is applied to RF1, and RF2 is terminated to a 50  $\Omega$  resistor to GND. In the open condition, power is applied to RF1 and RF2.

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

## THERMAL RESISTANCE

Thermal performance is directly linked to printed circuit board (PCB) design and operating environment. Careful attention to PCB thermal design is required.

Table 4. Thermal Resistance

Package Type	$\theta_{JA}$	$\theta_{JC}$	Unit
CP-8-13 <sup>1</sup>	48	1	°C/W

<sup>1</sup> Test condition: thermal impedance simulated values are based on JEDEC 2S2P thermal test board with four thermal vias. See JEDEC JESD51.

## 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 CONFIGURATIONS AND FUNCTION DESCRIPTIONS

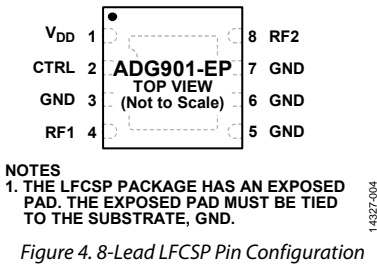


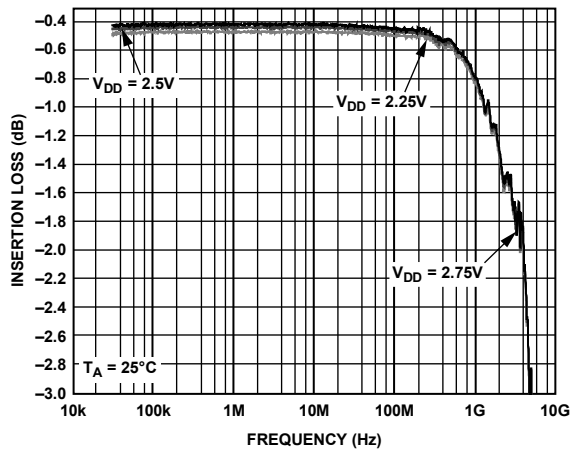
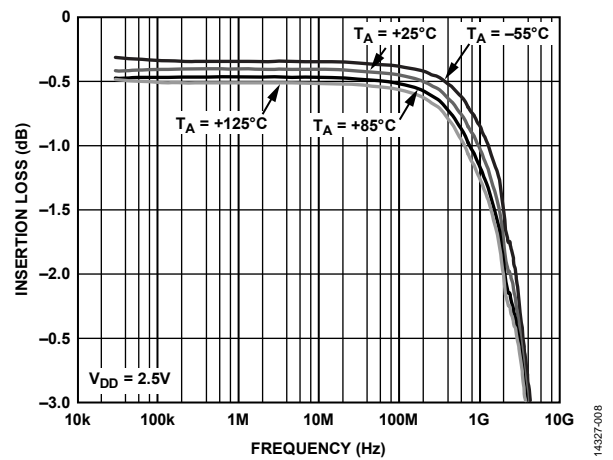
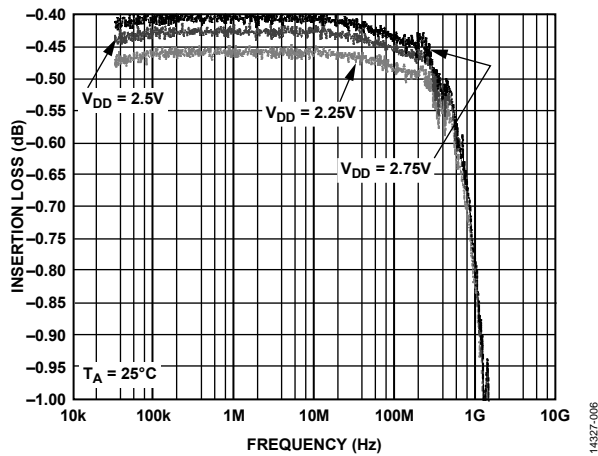
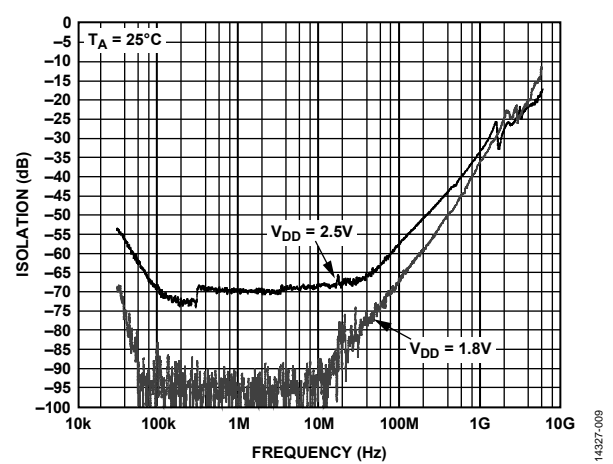
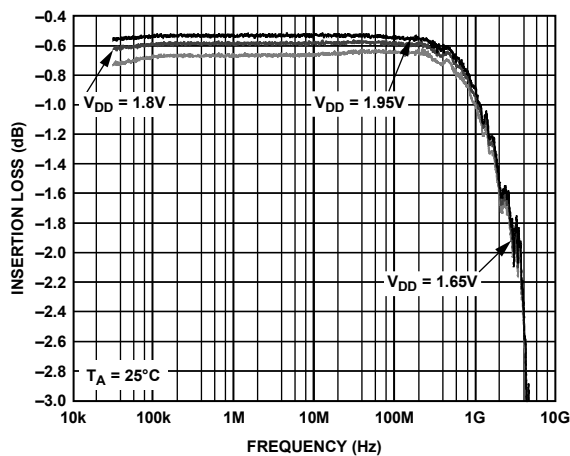
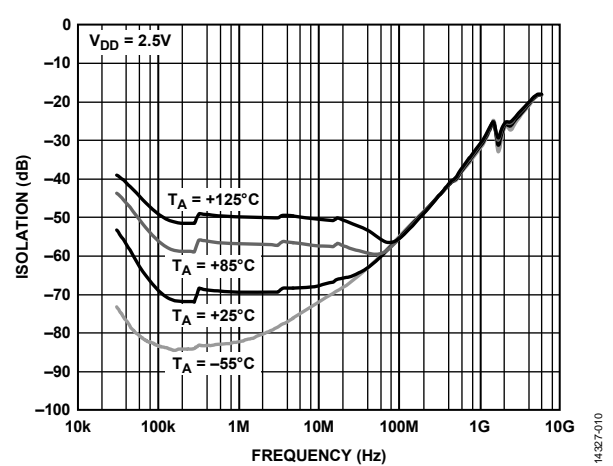
Table 5. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	V <sub>DD</sub>	Power Supply Input. These devices can be operated from 1.65 V to 2.75 V; decouple V <sub>DD</sub> to GND.
2	CTRL	CMOS or LVTTTL Logic Level. CTRL input must not exceed V <sub>DD</sub> . Logic 0: RF1 isolated from RF2. Logic 1: RF1 to RF2.
3, 5, 6, 7	GND	Ground Reference Point for All Circuitry on the Device.
4	RF1	RF1 Port.
8	RF2	RF2 Port.
	EPAD	Exposed Pad. The LFCSP package has an exposed pad. The exposed pad must be tied to the substrate, GND.

Table 6. Truth Table

CTRL	Signal Path
0	RF1 isolated from RF2
1	RF1 to RF2

## TYPICAL PERFORMANCE CHARACTERISTICS

Figure 5. Insertion Loss vs. Frequency over Supplies ( $S_{12}$  and  $S_{21}$ )Figure 8. Insertion Loss vs. Frequency over Temperature ( $S_{12}$  and  $S_{21}$ )Figure 6. Insertion Loss vs. Frequency over Supplies ( $S_{12}$  and  $S_{21}$ )  
(Zoomed Figure 5 Plot)Figure 9. Off Isolation vs. Frequency over Supplies ( $S_{12}$  and  $S_{21}$ )Figure 7. Insertion Loss vs. Frequency over Supplies ( $S_{12}$  and  $S_{21}$ )Figure 10. Off Isolation vs. Frequency over Temperature ( $S_{12}$  and  $S_{21}$ )

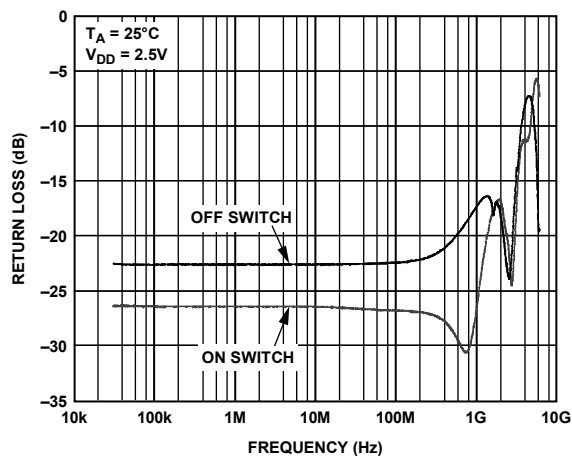


Figure 11. Return Loss vs. Frequency ( $S_{11}$ )

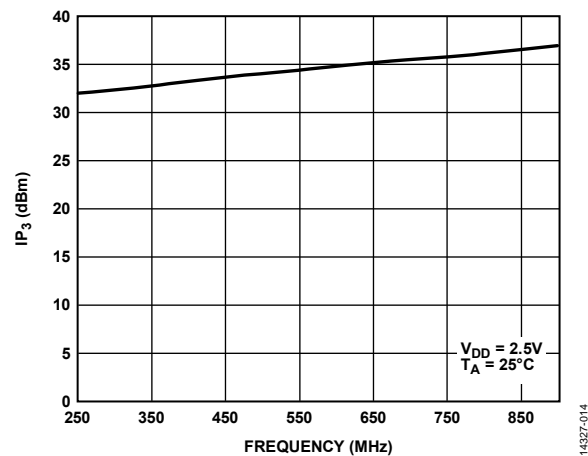


Figure 14.  $IP_3$  vs. Frequency

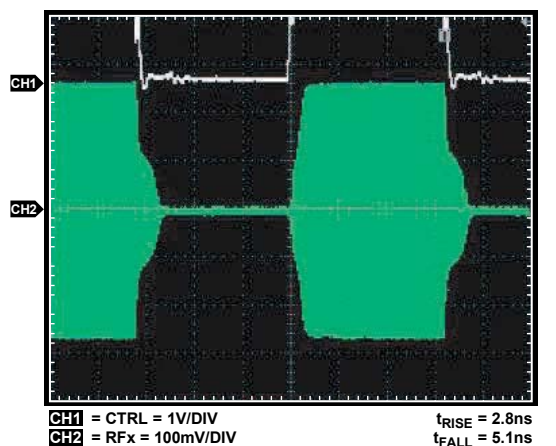


Figure 12. Switch Timing

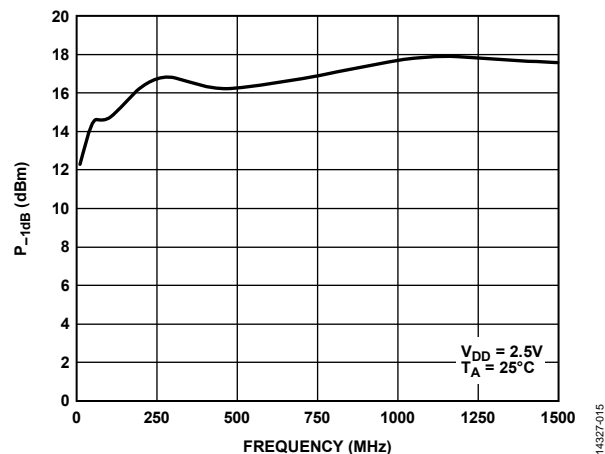


Figure 15.  $P_{1dB}$  vs. Frequency (DC Bias Not Used)

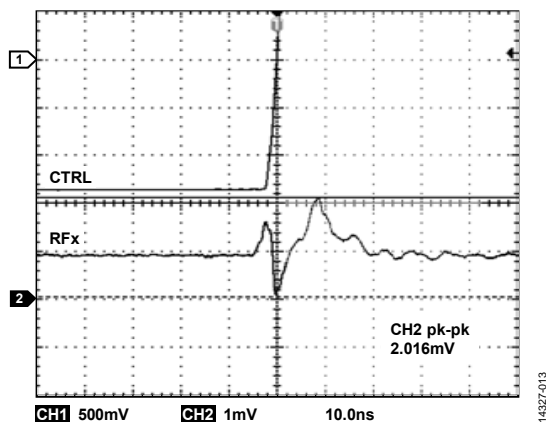


Figure 13. Video Feedthrough



## TERMINOLOGY

**V<sub>DD</sub>**

Most positive power supply potential.

**I<sub>DD</sub>**

Positive supply current.

**GND**

Ground (0 V) reference.

**CTRL**

Logic control input.

**V<sub>INL</sub>**

Maximum input voltage for Logic 0.

**V<sub>INH</sub>**

Minimum input voltage for Logic 1.

**I<sub>INL</sub> (I<sub>INH</sub>)**

Input current of the digital input.

**C<sub>IN</sub>**

Digital input capacitance.

**t<sub>ON</sub>**

Delay between applying the digital control input and the output switching on.

**t<sub>OFF</sub>**

Delay between applying the digital control input and the output switching off.

**t<sub>RISE</sub>**

Rise time. Time for the RF signal to rise from 10% to 90% of the on level.

**t<sub>FALL</sub>**

Fall time. Time for the RF signal to fall from 90% to 10% of the on level.

### Off Isolation

The attenuation between input and output ports of the switch when the switch control voltage is in the off condition.

### Insertion Loss

The attenuation between input and output ports of the switch when the switch control voltage is in the on condition.

### P1dB

1 dB compression point. The RF input power level at which the switch insertion loss increases by 1 dB over its low level value. It is a measure of how much power the on switch can handle before the insertion loss increases by 1 dB.

### IP<sub>3</sub>

Third-order intermodulation intercept. This is a measure of the power in false tones that occur when closely spaced tones are passed through a switch, whereby the nonlinearity of the switch causes these false tones to be generated.

### Return Loss

The amount of reflected power relative to the incident power at a port. Large return loss indicates good matching. By measuring return loss the VSWR can be calculated from conversion charts. voltage standing wave ratio (VSWR) indicates the degree of matching present at a switch RF port.

### Video Feedthrough

The spurious signals present at the RF ports of the switch when the control voltage is switched from high to low or low to high without an RF signal present.

## TEST CIRCUITS

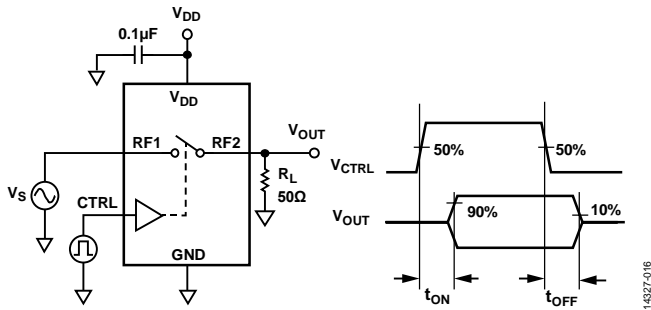


Figure 16. Switching Timing:  $t_{ON}$ ,  $t_{OFF}$

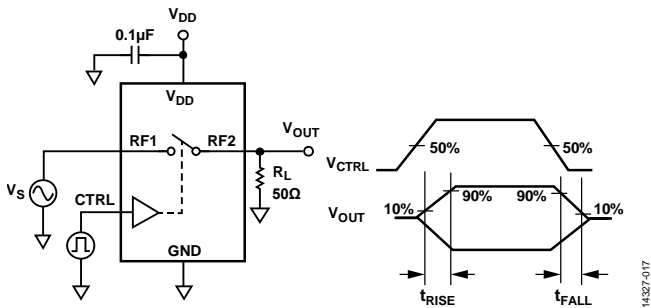


Figure 17. Switch Timing:  $t_{RISE}$ ,  $t_{FALL}$

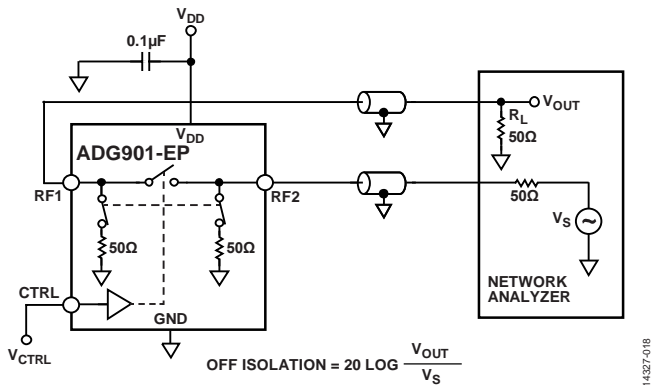


Figure 18. Off Isolation

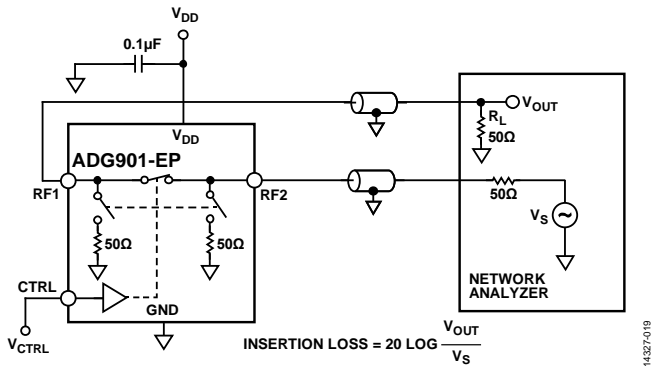


Figure 19. Insertion Loss

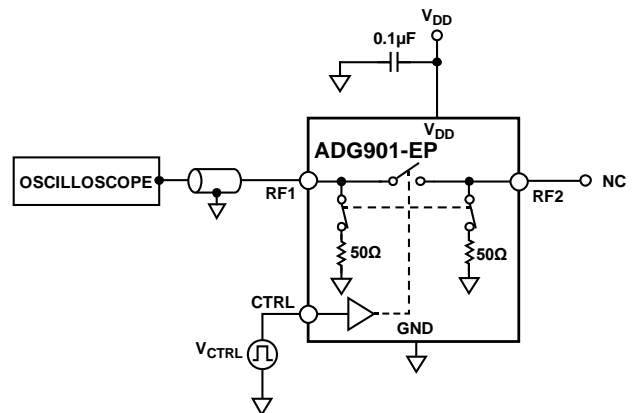


Figure 20. Video Feedthrough

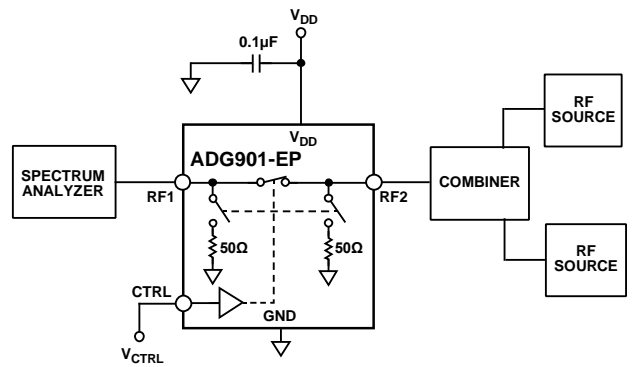


Figure 21. IP3

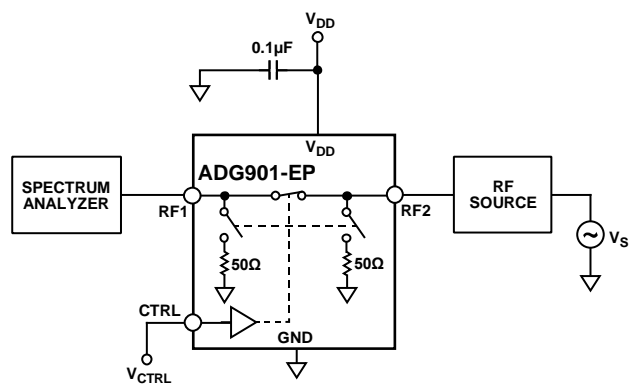
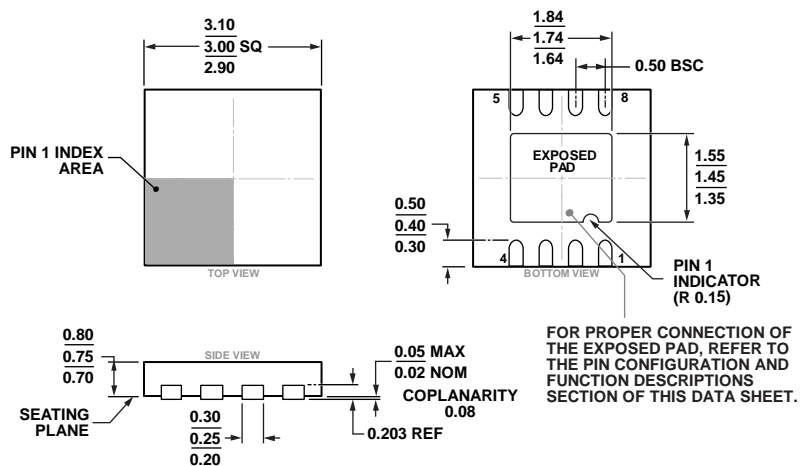


Figure 22. P1dB

## OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-229-WEED-4

Figure 23. 8-Lead Lead Frame Chip Scale Package [LFCSP]  
3 mm × 3 mm Body and 0.75 mm Package Height  
(CP-8-13)  
Dimensions shown in millimeters

## ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option	Branding
ADG901SCPZ-EP	–55°C to +125°C	8-Lead Lead Frame Chip Scale Package [LFCSP]	CP-8-13	S4K
ADG901SCPZ-EP-RL7	–55°C to +125°C	8-Lead Lead Frame Chip Scale Package [LFCSP]	CP-8-13	S4K

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