

**FEATURES**

**Wideband switch: -3 dB at 4 GHz**  
**Absorptive/reflective switches**  
**High off isolation (43 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**  
**8-lead MSOP and tiny 3 mm × 3 mm LFCSP**  
**Low power consumption (<1 μA)**

**APPLICATIONS**

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

**GENERAL DESCRIPTION**

The [ADG918/ADG919](#) are wideband switches using a CMOS process to provide high isolation and low insertion loss to 1 GHz. The [ADG918](#) is an absorptive (matched) switch having 50 Ω terminated shunt legs, whereas the [ADG919](#) is a reflective switch. These devices are designed such that the isolation is high over the dc to 1 GHz frequency range. They have 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 these CMOS devices makes them ideally suited to wireless and general-purpose high frequency switching applications.

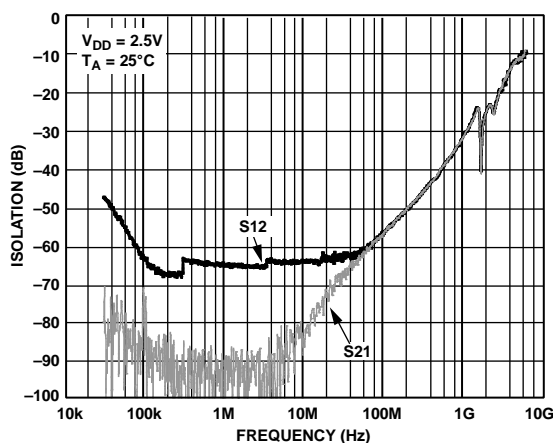


Figure 1. Off Isolation vs. Frequency

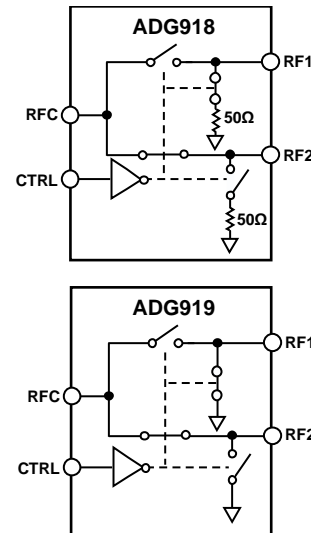
**FUNCTIONAL BLOCK DIAGRAMS**


Figure 2.

**PRODUCT HIGHLIGHTS**

1. -43 dB off isolation at 1 GHz.
2. 0.8 dB insertion loss at 1 GHz.
3. Tiny 8-lead MSOP/LFCSP.

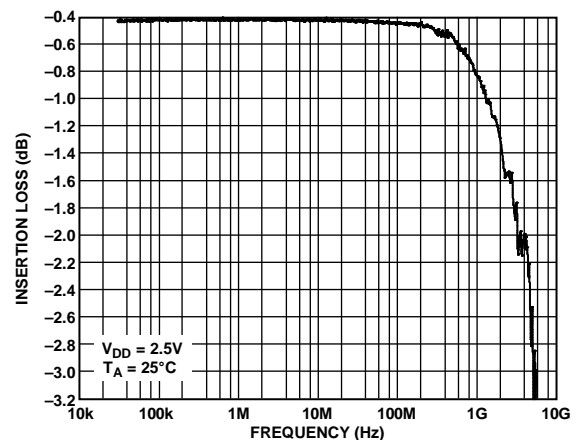


Figure 3. Insertion Loss vs. Frequency

Rev. D

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**REVISION HISTORY**

**3/16—Rev. C to Rev. D**

Changed CP-8-2 to CP-8-13 ..... Throughout  
 Changes to Figure 4 and Table 3..... 6  
 Added Figure 5, Renumbered Sequentially ..... 6  
 Changed ADG9xx Evaluation Board Section to ADG918/  
 ADG919 Evaluation Board Section ..... 14  
 Updated Outline Dimensions ..... 15  
 Changes to Ordering Guide ..... 16

**9/08—Rev. B to Rev. C**

Changes to Ordering Guide ..... 16

**8/08—Rev. A to Rev. B**

Changes to Table 1, AC Electrical Characteristics, Third Order  
 Intermodulation Intercept..... 3  
 Updated Outline Dimensions ..... 15  
 Changes to Ordering Guide ..... 16

**9/04—Rev. 0 to Rev. A**

Updated Format..... Universal  
 Change to Data Sheet Title.....1  
 Change to Features .....1  
 Change to Product Highlights .....1  
 Changes to Specifications.....3  
 Change to ADG9xx Evaluation Board section ..... 13  
 Changes to Ordering Guide ..... 14

**8/03—Revision 0: Initial Version**

## SPECIFICATIONS

$V_{DD} = 1.65\text{ V to }2.75\text{ V}$ ,  $GND = 0\text{ V}$ , input power = 0 dBm, all specifications  $T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Temperature range for B Version:  $-40^{\circ}\text{C to }+85^{\circ}\text{C}$ .

Table 1.

| Parameter  | Symbol             | Test Conditions/Comments                        | B Version     |                  |               | Unit          |
|--|--------------------|---|---------------|------------------|---------------|---------------|
|  |                    |   | Min           | Typ <sup>1</sup> | Max           |               |
| AC ELECTRICAL CHARACTERISTICS                    |                    |   |               |                  |               |               |
| Operating Frequency <sup>2</sup>                 |                    |   | dc            |                  | 2             | GHz           |
| 3 dB Frequency <sup>3</sup>                      |                    |   |               |                  | 4             | GHz           |
| Input Power <sup>3</sup>                         |                    | 0 V dc bias                                     |               |                  | 7             | dBm           |
|  |                    | 0.5 V dc bias                                   |               |                  | 16            | dBm           |
| Insertion Loss                                   | $S_{21}, S_{12}$   | DC to 100 MHz; $V_{DD} = 2.5\text{ V} \pm 10\%$ |               | 0.4              | 0.7           | dB            |
|  |                    | 500 MHz; $V_{DD} = 2.5\text{ V} \pm 10\%$       |               | 0.5              | 0.8           | dB            |
|  |                    | 1000 MHz; $V_{DD} = 2.5\text{ V} \pm 10\%$      |               | 0.8              | 1.25          | dB            |
| Isolation—RFC to RF1/RF2<br>(CP Package)         | $S_{21}, S_{12}$   | 100 MHz   | 57            | 60               |               | dB            |
|  |                    | 500 MHz   | 46            | 49               |               | dB            |
|  |                    | 1000 MHz  | 36            | 43               |               | dB            |
| Isolation—RFC to RF1/RF2<br>(RM Package)         | $S_{21}, S_{12}$   | 100 MHz   | 55            | 60               |               | dB            |
|  |                    | 500 MHz   | 43            | 47               |               | dB            |
|  |                    | 1000 MHz  | 34            | 37               |               | dB            |
| Isolation—RF1 to RF2 (Crosstalk)<br>(CP Package) | $S_{21}, S_{12}$   | 100 MHz   | 55            | 58               |               |               |
|  |                    | 500 MHz   | 41            | 44               |               |               |
|  |                    | 1000 MHz  | 31            | 37               |               |               |
| Isolation—RF1 to RF2 (Crosstalk)<br>(RM Package) | $S_{21}, S_{12}$   | 100 MHz   | 54            | 57               |               |               |
|  |                    | 500 MHz   | 39            | 42               |               |               |
|  |                    | 1000 MHz  | 31            | 33               |               |               |
| Return Loss (On Channel) <sup>3</sup>            | $S_{11}, S_{22}$   | DC to 100 MHz                                   | 21            | 27               |               | dB            |
|  |                    | 500 MHz   | 22            | 27               |               | dB            |
|  |                    | 1000 MHz  | 22            | 26               |               | dB            |
| Return Loss (Off Channel) <sup>3</sup><br>ADG918 | $S_{11}, S_{22}$   | DC to 100 MHz                                   | 18            | 23               |               | dB            |
|  |                    | 500 MHz   | 17            | 21               |               | dB            |
|  |                    | 1000 MHz  | 16            | 20               |               | dB            |
| On Switching Time <sup>3</sup>                   | $t_{ON}$           | 50% CTRL to 90% RF                              |               | 6.6              | 10            | ns            |
| Off Switching Time <sup>3</sup>                  | $t_{OFF}$          | 50% CTRL to 10% RF                              |               | 6.5              | 9.5           | ns            |
| Rise Time <sup>3</sup>                           | $t_{RISE}$         | 10% to 90% RF                                   |               | 6.1              | 9             | ns            |
| Fall Time <sup>3</sup>                           | $t_{FALL}$         | 90% to 10% RF                                   |               | 6.1              | 9             | ns            |
| 1 dB Compression <sup>3</sup>                    | $P_{-1\text{ dB}}$ | 1000 MHz  |               | 17               |               | dBm           |
| Third Order Intermodulation Intercept            | $IP_3$             | 900 MHz/901 MHz, 4 dBm                          | 28.5          | 36               |               | dBm           |
| Video Feedthrough <sup>4</sup>                   |                    |   |               | 2.5              |               | mV p-p        |
| 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 $V_{CC}$ |                  |               | 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 $V_{CC}$ | V             |
| Input Leakage Current                            | $I_I$              | $0\text{ V} \leq V_{IN} \leq 2.75\text{ V}$     |               | $\pm 0.1$        | $\pm 1$       | $\mu\text{A}$ |

| Parameter                      | Symbol             | Test Conditions/Comments                | B Version |                  |      | Unit |
|--------------------------------|--------------------|---|-----------|------------------|------|------|
|                                |                    |   | Min       | Typ <sup>1</sup> | Max  |      |
| CAPACITANCE <sup>3</sup>       |                    |   |           |                  |      |      |
| RF On Capacitance              | C <sub>RF ON</sub> | f = 1 MHz                               |           | 1.6              |      | pF   |
| CTRL Input Capacitance         | C <sub>CTRL</sub>  | f = 1 MHz                               |           | 2                |      | pF   |
| POWER REQUIREMENTS             |                    |   |           |                  |      |      |
| V <sub>DD</sub>                |                    |   | 1.65      |                  | 2.75 | V    |
| Quiescent Power Supply Current | I <sub>DD</sub>    | Digital inputs = 0 V or V <sub>DD</sub> |           | 0.1              | 1    | μA   |

<sup>1</sup> Typical values are at V<sub>DD</sub> = 2.5 V and 25°C, unless otherwise stated.

<sup>2</sup> Point at which insertion loss degrades by 1 dB.

<sup>3</sup> Guaranteed by design, not subject to production test.

<sup>4</sup> 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 Ω test setup, measured with 1 ns rise time pulses and 500 MHz bandwidth.

## ABSOLUTE MAXIMUM RATINGS

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

Table 2.

| Parameter                             | Rating  |
|---------------------------------------|---|
| $V_{DD}$ to GND                       | -0.5 V to +4 V                                  |
| Inputs to GND                         | -0.5 V to $V_{DD} + 0.3 \text{ V}$ <sup>1</sup> |
| Continuous Current                    | 30 mA   |
| Input Power                           | 18 dBm  |
| Operating Temperature Range           |   |
| Industrial (B Version)                | -40°C to +85°C                                  |
| Storage Temperature Range             | -65°C to +150°C                                 |
| Junction Temperature                  | 150°C   |
| $\theta_{JA}$ Thermal Impedance       |   |
| MSOP                                  | 206°C/W   |
| LFCSP                                 |   |
| 2-Layer Board                         | 84°C/W  |
| 4-Layer Board                         | 48°C/W  |
| Lead Temperature, Soldering (10 sec)  | 300°C   |
| IR Reflow, Peak Temperature (<20 sec) | 235°C   |
| ESD                                   | 1 kV  |

<sup>1</sup>RF1 and RF2 off port inputs to ground: -0.5 V to  $V_{DD} - 0.5 \text{ V}$ .

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.

### 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

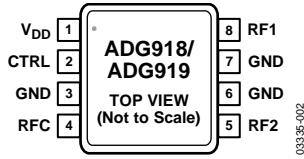
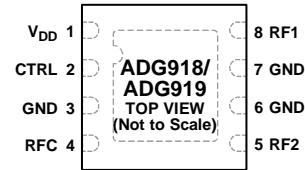


Figure 4. ADG918/ADG919 Pin Configuration (MSOP)



NOTES  
 1. EXPOSED PAD. TIE THE EXPOSED PAD TO SUBSTRATE, GND.

Figure 5. ADG918/ADG919 Pin Configuration (LFCSP)

Table 3. Pin Function Descriptions

| Pin No.        |         | Mnemonic        | Function  |
|----------------|---------|-----------------|---|
| MSOP           | LFCSP   |                 |   |
| 1              | 1       | V <sub>DD</sub> | Power Supply Input. These parts can be operated from 1.65 V to 2.75 V; decouple V <sub>DD</sub> to GND. |
| 2              | 2       | CTRL            | Logic Control Input. See Table 4.   |
| 3, 6, 7        | 3, 6, 7 | GND             | Ground Reference Point for All Circuitry on the Part.   |
| 4              | 4       | RFC             | COMMON RF Port for Switch.  |
| 5              | 5       | RF2             | RF2 Port.   |
| 8              | 8       | RF1             | RF1 Port.   |
| Not applicable | 0       | EPAD            | Exposed Pad. Tie the exposed pad to substrate, GND.   |

Table 4. Truth Table

| CTRL | Signal Path |
|------|-------------|
| 0    | RF2 to RFC  |
| 1    | RF1 to RFC  |

TYPICAL PERFORMANCE CHARACTERISTICS

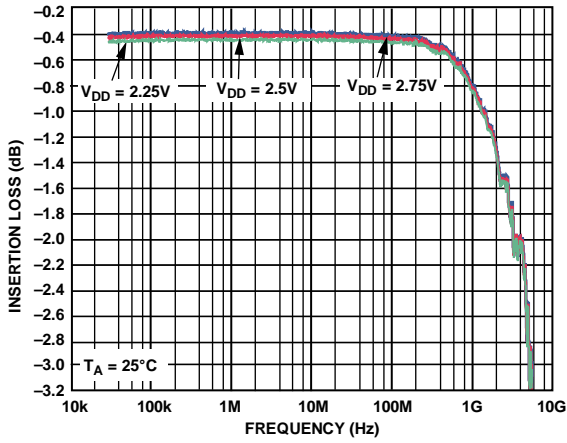


Figure 6. Insertion Loss vs. Frequency over Supplies (RF1/RF2, S12, and S21)

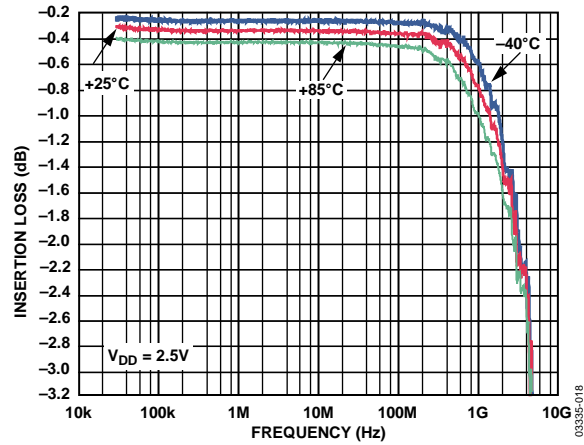


Figure 9. Insertion Loss vs. Frequency over Temperature (RF1/RF2, S12, and S21)

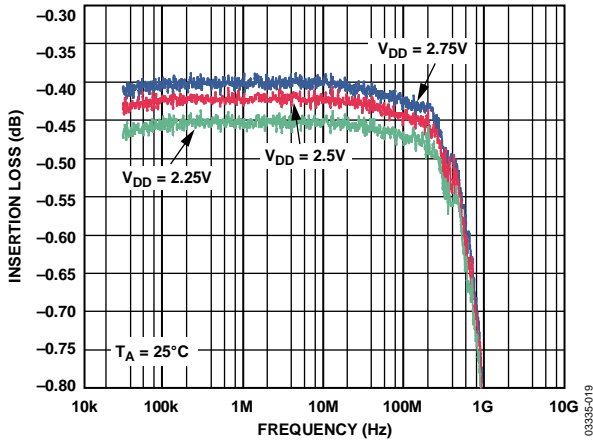


Figure 7. Insertion Loss vs. Frequency over Supplies (RF1/RF2, S12, and S21) (Zoomed Figure 5 Plot)

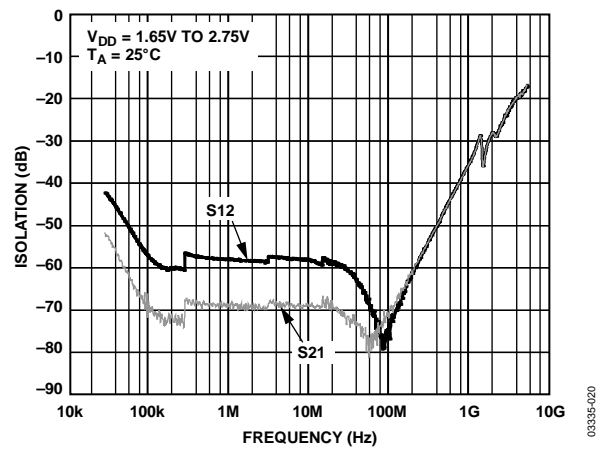


Figure 10. Isolation vs. Frequency over Supplies (RF1/RF2, ADG918)

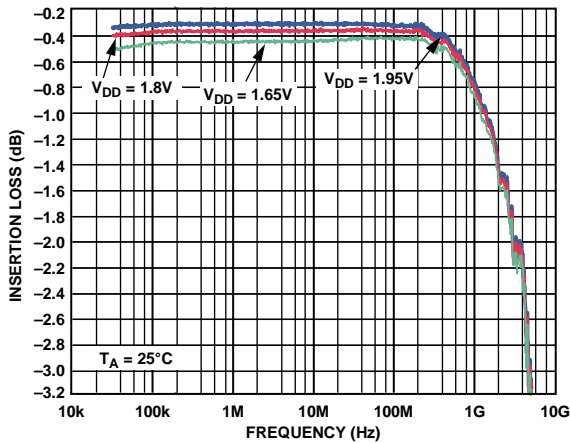


Figure 8. Insertion Loss vs. Frequency over Supplies (RF1/RF2, S12, and S21)

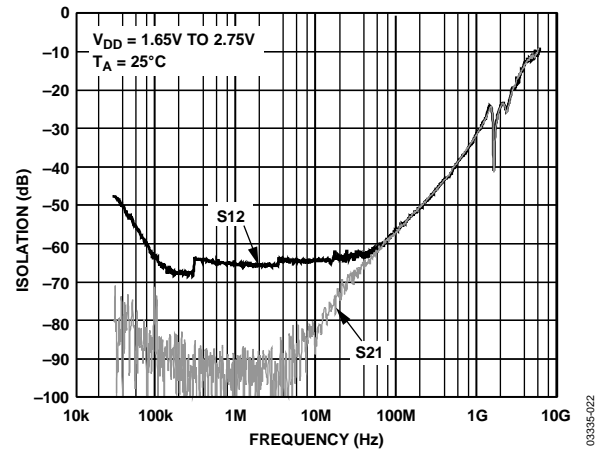
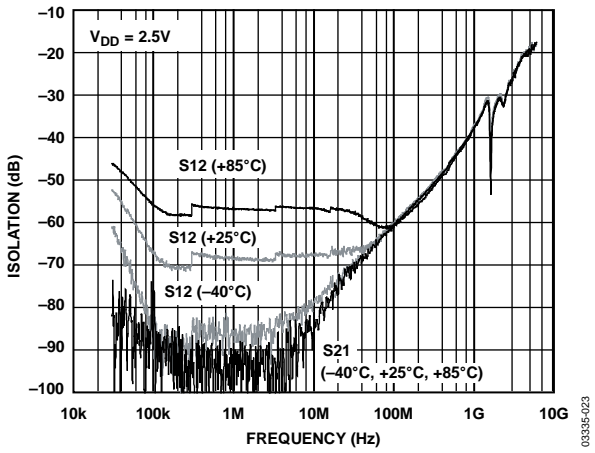
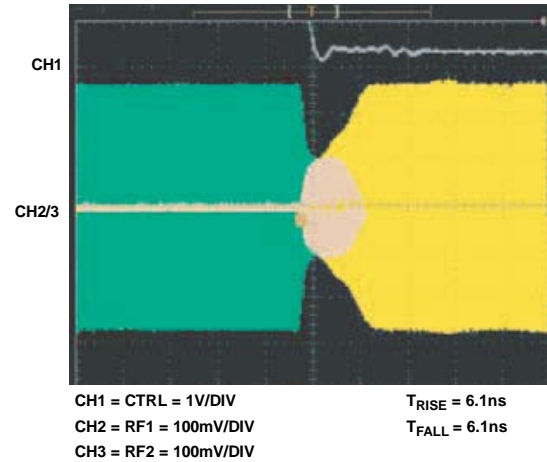


Figure 11. Isolation vs. Frequency over Supplies (RF1/RF2, ADG919)



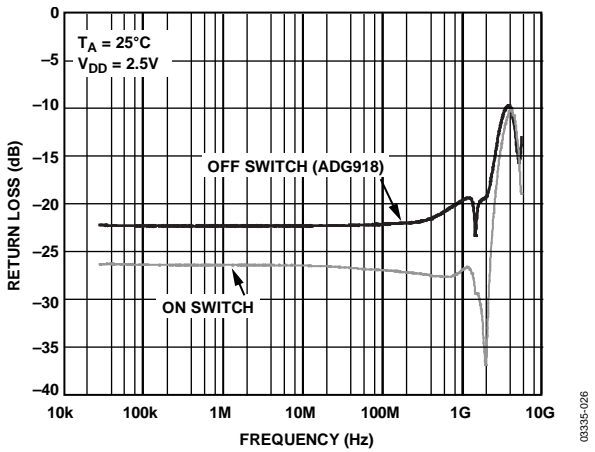
03335-023

Figure 12. Isolation vs. Frequency over Temperature (RF1/RF2, ADG919)



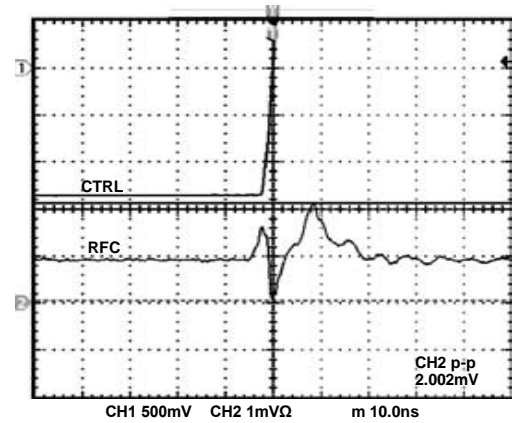
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Figure 15. Switch Timing



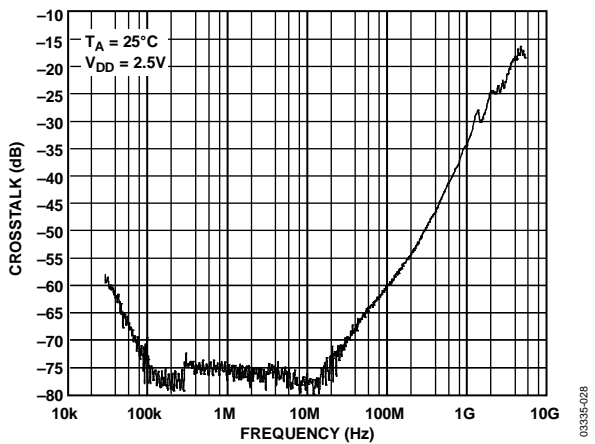
03335-026

Figure 13. Return Loss vs. Frequency (RF1/RF2, S11)



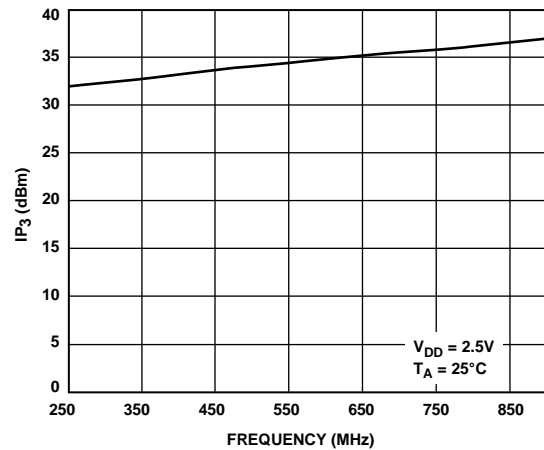
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Figure 16. Video Feedthrough



03335-028

Figure 14. Crosstalk vs. Frequency (RF1/RF2, S12, S21)



03335-029

Figure 17. IP3 vs. Frequency



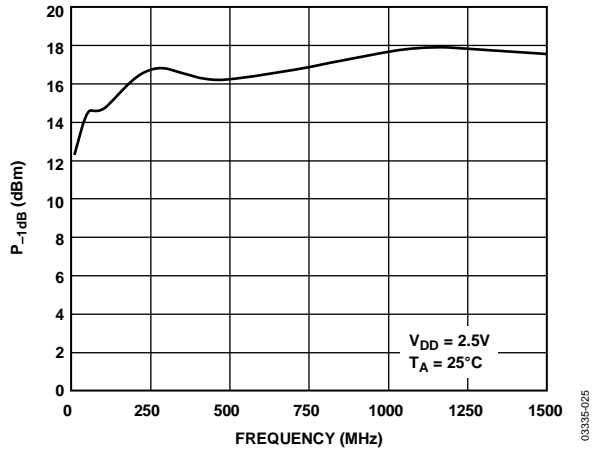


Figure 18.  $P_{-1dB}$  vs. Frequency

03335-025

## 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 the input and output ports of the switch when the switch control voltage is in the off condition.

### Insertion Loss

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

**P<sub>-1 dB</sub>**

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 (voltage standing wave ratio) can be calculated from conversion charts. VSWR indicates the degree of matching present at a switch RF port.

### Video Feedthrough

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

Setups for the [ADG918](#) are similar.

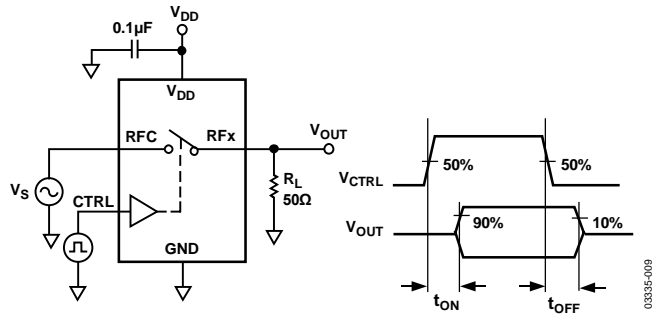


Figure 19. Switch Timing:  $t_{ON}$ ,  $t_{OFF}$

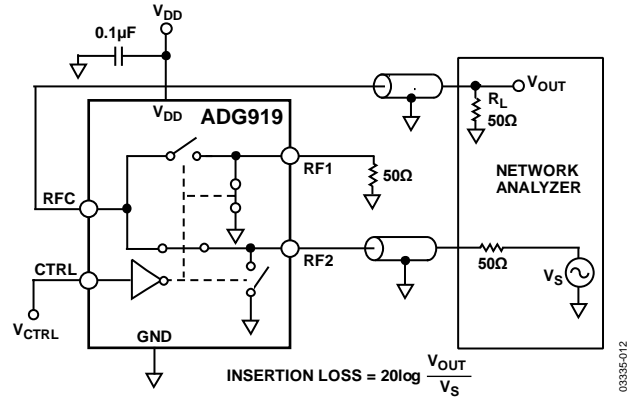


Figure 22. Insertion Loss

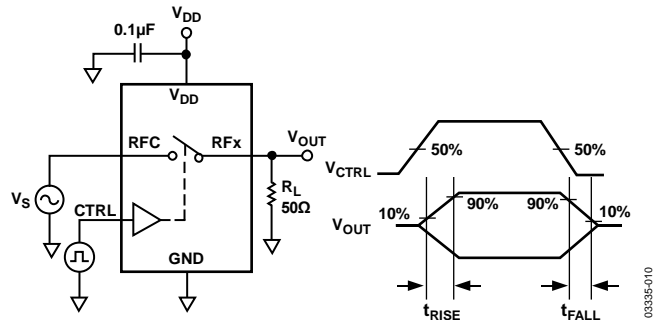


Figure 20. Switch

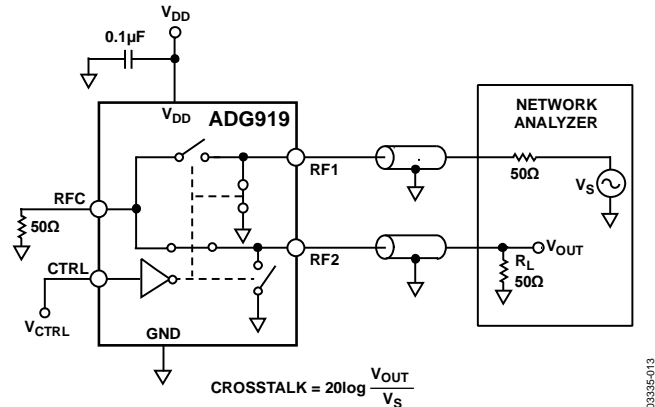


Figure 23. Crosstalk

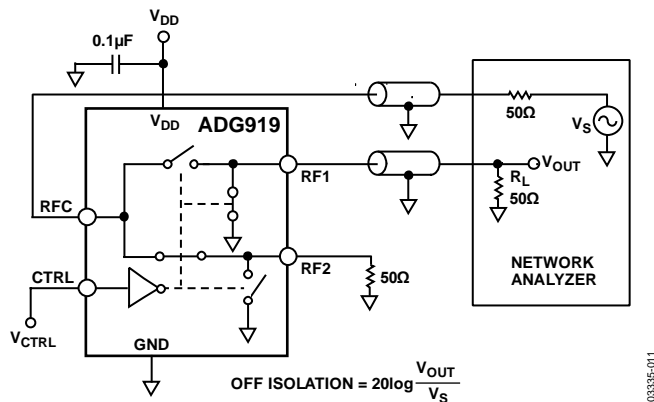


Figure 21. Off Isolation

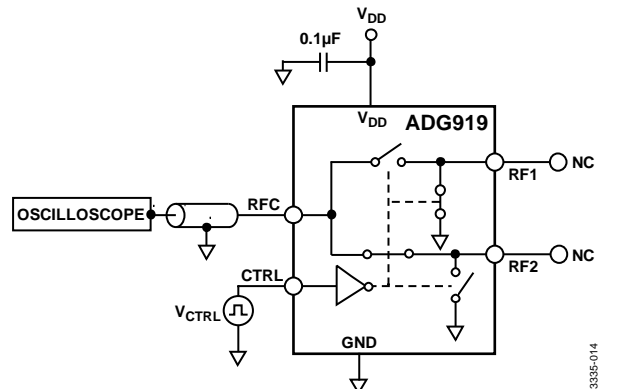


Figure 24. Video Feedthrough

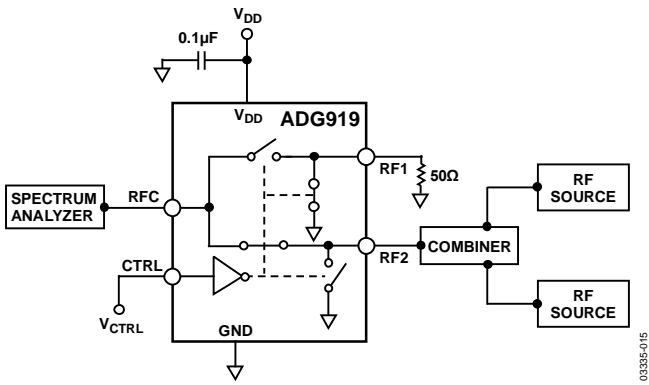


Figure 25.  $IP_3$

03335-015

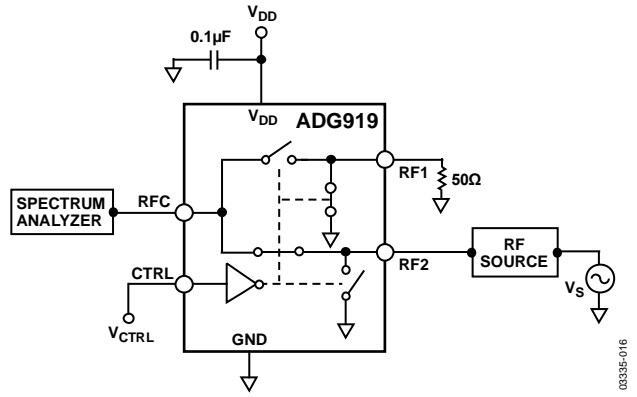


Figure 26.  $P_{-1dB}$

03335-016

## APPLICATIONS INFORMATION

The [ADG918/ADG919](#) are ideal solutions for low power, high frequency applications. The low insertion loss, high isolation between ports, low distortion, and low current consumption of these parts make them excellent solutions for many high frequency switching applications. The most obvious application is in a transmit/receive block, as shown in the wireless metering block diagram in Figure 27.

Other applications include switching between high frequency filters, an ASK generator, an FSK generator, and an antenna diversity switch in many tuner modules.

### ABSORPTIVE VS. REFLECTIVE SWITCH

The [ADG918](#) is an absorptive (matched) switch with 50  $\Omega$  terminated shunt legs, and the [ADG919](#) is a reflective switch with 0  $\Omega$  terminated shunts to ground. The [ADG918](#) absorptive switch has a good VSWR on each port, regardless of the switch mode. An absorptive switch should be used when there is a need for a good VSWR that is looking into the port but not passing the through signal to the common port. The [ADG918](#) is therefore ideal for applications that require minimum reflections back to the RF source. It also ensures that the maximum power is transferred to the load.

The [ADG919](#) reflective switch is suitable for applications where high off port VSWR does not matter and the switch has some other desired performance feature. It can be used in many applications, including high speed filter selection. In most cases, an absorptive switch can be used instead of a reflective switch, but not vice versa.

### WIRELESS METERING

The [ADG918](#) can be used in wireless metering applications. It can be used in conjunction with the [ADF7020](#) transceiver IC for

a utility metering transceiver application, providing the required isolation between the transmit and receive signals. The SPDT configuration isolates the high frequency receive signal from the high frequency transmit.

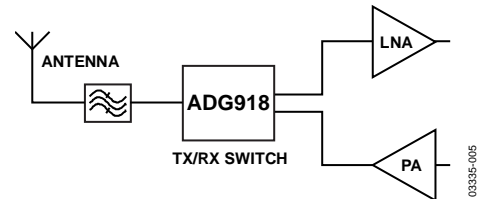


Figure 27. Wireless Metering

### TUNER MODULES

The [ADG918](#) can be used in a tuner module to switch between the cable TV input and the off-air antenna. This part is also ideal for use as an antenna diversity switch, switching different antenna to the tuner.

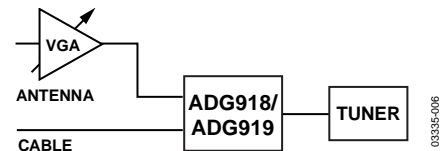


Figure 28. Tuner Modules

### FILTER SELECTION

The [ADG919](#) can be used as a 2:1 demultiplex to switch high frequency signals between different filters and also to multiplex the signal to the output.

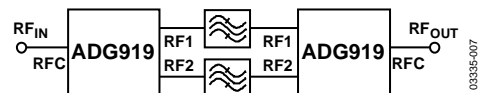


Figure 29. Filter Selection

## ADG918/ADG919 EVALUATION BOARD

The ADG918/ADG919 evaluation board allows designers to evaluate the high performance wideband switches with a minimum of effort.

In addition to the evaluation board, the user requires only a power supply and a network analyzer. An application note is available with the evaluation board and gives complete information about operating the evaluation board.

The RFC port (see Figure 30) is connected through a 50  $\Omega$  transmission line to the top left SMA connector J1. RF1 and RF2 are connected through 50  $\Omega$  transmission lines to the top two SMA connectors, J2 and J3 respectively. A through transmission line connects J4 and J5 and is used to estimate the loss of the PCB over the environmental conditions being evaluated.

The board is constructed of a 4-layer, FR4 material with a dielectric constant of 4.3 and an overall thickness of 0.062 inches. Two ground layers with grounded planes provide ground for the RF transmission lines. The transmission lines were designed using a coplanar waveguide with ground plane model using a trace width of 0.052 inches, a clearance to ground plane of 0.030 inches, a dielectric thickness of 0.029 inches, and a metal thickness of 0.014 inches.

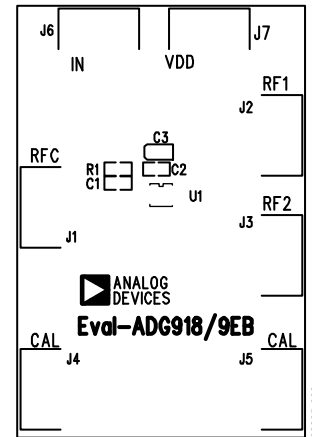


Figure 30. ADG918/ADG919 Evaluation Board Top View

OUTLINE DIMENSIONS

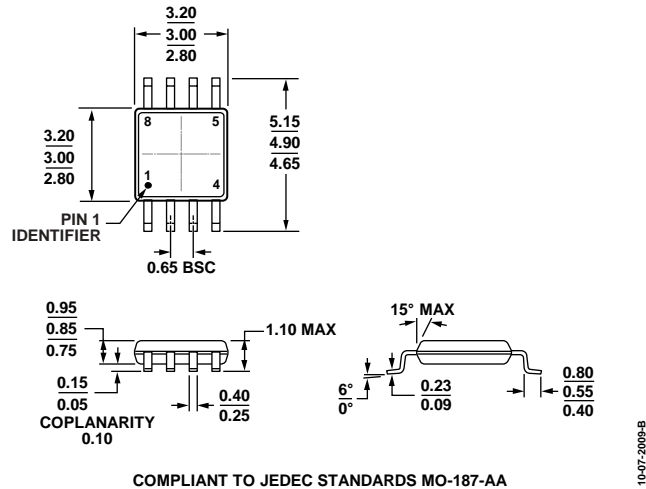


Figure 31. 8-Lead Mini Small Outline Package [MSOP] (RM-8)

Dimensions shown in millimeters

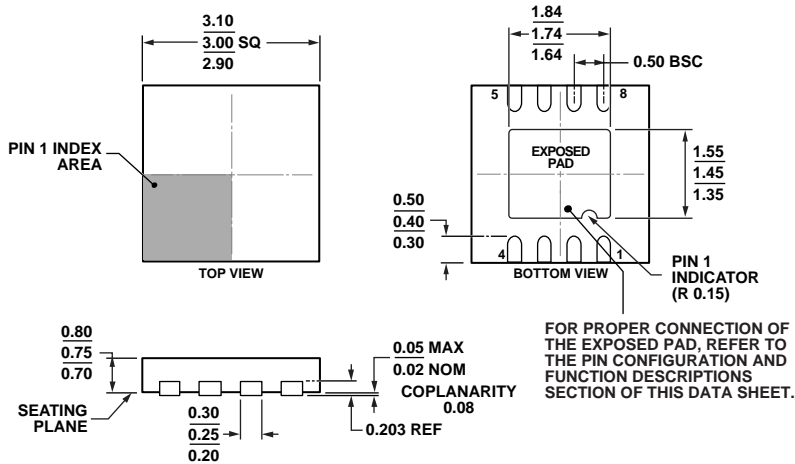


Figure 32. 8-Lead Lead Frame Chip Scale Package [LF CSP] 3 mm x 3 mm Body and 0.75 mm Package Height (CP-8-13)

Dimensions shown in millimeters

## ORDERING GUIDE

| Model <sup>1</sup> | Temperature Range | Package Description                          | Package Option | Branding |
|--------------------|-------------------|--|----------------|----------|
| ADG918BRM          | -40°C to +85°C    | 8-Lead Mini Small Outline Package [MSOP]     | RM-8           | W4B      |
| ADG918BRM-REEL7    | -40°C to +85°C    | 8-Lead Mini Small Outline Package [MSOP]     | RM-8           | W4B      |
| ADG918BRMZ         | -40°C to +85°C    | 8-Lead Mini Small Outline Package [MSOP]     | RM-8           | W4B#     |
| ADG918BRMZ-500RL7  | -40°C to +85°C    | 8-Lead Mini Small Outline Package [MSOP]     | RM-8           | W4B#     |
| ADG918BRMZ-REEL    | -40°C to +85°C    | 8-Lead Mini Small Outline Package [MSOP]     | RM-8           | W4B#     |
| ADG918BRMZ-REEL7   | -40°C to +85°C    | 8-Lead Mini Small Outline Package [MSOP]     | RM-8           | W4B#     |
| ADG918BCPZ-500RL7  | -40°C to +85°C    | 8-Lead Lead Frame Chip Scale Package [LFCSP] | CP-8-13        | W4B#     |
| ADG918BCPZ-REEL7   | -40°C to +85°C    | 8-Lead Lead Frame Chip Scale Package [LFCSP] | CP-8-13        | W4B#     |
| ADG919BRMZ         | -40°C to +85°C    | 8-Lead Mini Small Outline Package [MSOP]     | RM-8           | S1X      |
| ADG919BRMZ-REEL7   | -40°C to +85°C    | 8-Lead Mini Small Outline Package [MSOP]     | RM-8           | S1X      |
| ADG919BCPZ-REEL7   | -40°C to +85°C    | 8-Lead Lead Frame Chip Scale Package [LFCSP] | CP-8-13        | S1X      |
| EVAL-ADG918EBZ     |                   | Evaluation Board                             |                |          |
| EVAL-ADG919EBZ     |                   | Evaluation Board                             |                |          |

<sup>1</sup> Z = RoHS Compliant Part, # denotes RoHS compliant product may be top or bottom marked.