Assembly Site Transfer of Select Side by Side LFCSP at ASE Korea

Qualification Results Summary for Side by Side LFCSP at AEK

TEST	SPECIFICATION	SAMPLE SIZE	RESULT
Temperature Cycle (TC)*	JEDEC *JESD22-A104*	3 x 77	PASS
Solder Heat Resistance (SHR)*	JEDEC/IPC *J-STD-020*	3 x 11	PASS
Highly Accelerated Stress Test (HAST)*	JEDEC *JESD22-A110*	3 x 77	PASS
High Temperature Storage (HTS)	JEDEC *JESD22-A103*	1 x 77	PASS
Unbiased Highly Accelerated Stress Test (UHAST)*	JEDEC *JESD22-A118*	3 x 77	PASS

* Preconditioned per JEDEC/IPC J-STD-020.

PCN 18_0036

ADGM1304 Data Sheet Changes

Rev.D to Rev.E

This document highlights the changes from the Rev. D to the Rev. E data sheet for the ADGM1304 SP4T MEMS switch with integrated driver.

In brief following changes are made from Rev D to Rev E data sheet.

- *Wider operating voltage range*
- *Improved internal oscillator feedthrough noise*
- *Improved RON specification*
- *Added SPI functionality*

For full product information and changes to pin configuration of the part please refer to the ADGM1304 Rev. E data sheet.

1. Specification changes from datasheet Rev. D to Rev. E

Table 1 outlines the datasheet specifications which are changed in Rev. E material as compared to Rev.D material. The changed specifications are highlighted in red font.
Table 2 outlines the datasheet specifications which are added to Rev.E material.
Table 3 outlines the datasheet specifications which are removed from Rev.D material.

2. Absolute Maximum Rating from datasheet Rev. D to Rev. E

Table 4 outlines the Absolute Maximum Rating comparison of the Rev. D to Rev. E material. The changed specifications are highlighted in red font.

3. Pin Configuration changes from datasheet Rev. D to Rev. E

Table 5 outlines the pin configuration comparison of the Rev. D to Rev. E material and Table 6 highlights pin function descriptions. All the changed pins configuration are highlighted in red font.

4. Typical Operating Circuit changes from datasheet Rev. D to Rev. E

Figure 3 and Figure 4 outlines the typical operating circuit comparison of the Rev. D to Rev. E material. There are no changes to typical operating circuit in parallel mode for both Rev D and Rev E material.

5. RON Drift

Table 7 outlines the RON drift specification. This section explains about RON performance and RON drift of the ADGM1304. The RON performance of the MEMS switch is affected by part to part variation, channel to channel variation, cycle actuations, settling time post turn on, bias voltage and Temperature changes.

SPECIFICATIONS CHANGED

V_{DD} = 3.0 V to 3.6V, AGND = 0 V, RFGND = 0 V, all specifications minimum temperature (T_{MIN}) to maximum temperature (T_{MAX}) = 0°C to +85°C, unless otherwise noted.

Table 1.

		Rev D			Rev E				
Parameter	**Symbol**	**Min**	**Typ**[1]	**Max**	**Min**	**Typ**[1]	**Max**	**Unit**	**Test Conditions/Comments**
DYNAMIC CHARACTERISTICS									
Isolation	I_{SO}								
RFx To RFC (All Off)		17	19		16	19		dB	At 6.0 GHz, RFC to RFx channel (All Channels Off)
Input Second-Order Intermodulation Intercept	IIP2		119			111		dBm	Input: 900 MHz and 901 MHz, input power = 27 dBm
Radio Frequency (RF) Power Rating [2]				36			36	dBm	Switch in the on state and terminated into 50 Ω; max specification tested at 25°C
On Switching Time [3]	t_{ON}		30	75	0		75	µs	50% INx to 90% (0.05dB of final IL value) RFx, 50 Ω termination
Off Switching Time[3]	t_{OFF}		5	30	0		75	µs	50% INx to 10% (0.05dB of final IL value) RFx, 50 Ω termination
Internal Oscillator Frequency		7.9		15	8	10	12	MHz	
Internal Oscillator Feedthrough [4]			−115			−123		dBm	Spectrum analyzer resolution bandwidth (RBW) = 200 Hz; one switch in on state, all other switches off with 50 Ω terminations [5]
SWITCH PROPERTIES									For more details see ON RESISTANCE (RON) PROPERTIES
On Resistance	RON		1.6	3.6			2.9	Ω	Drain source current (I_{DS}) = 50 mA, 0 V input bias, at 1 ms
On Resistance Stability	ΔRON		1.4			0.5		Ω	10^9 actuations; ~~full temperature range; 1 kHz cycling frequency; 220 mA load between toggles,~~ switch is actuated at 25°C and RON is measured at 25°C
							5	Ω	10^9 actuations, switch is actuated at 85°C and RON is measured at 25°C, 1kHz actuating frequency, 220 mA load applied between toggles[6]
POWER REQUIREMENTS									
Supply Voltage	V_{DD}	3.1		3.3	3.0		3.6	V	
Supply Current	I_{DD}		2.9	3.2			2.5	mA	Digital inputs = 0 V or V_{DD}, serial data out (SDO) is floating in serial peripheral interface (SPI) mode

[1] Typical specifications tested at 25°C with V_{DD} = 3.3 V.
[2] The 1 dB compression point (P1dB) is not reached up to the maximum power rating of the switch.
[3] Switch is settled after 75 µs. Do not apply RF power between 0 µs to 75 µs.
[4] Disable the internal oscillator to eliminate feedthrough.
[5] The spectrum analyzer setup is as follows: RBW = 200 Hz, video bandwidth (VBW) = 2 Hz, span = 100 kHz, input attenuator = 0 dB, the detector type is peak, and the maximum hold is off. The fundamental feedthrough noise or harmonic thereof (whichever is higher) is tested.
[6] Actuating the switch at 85°C and measuring RON at 25°C is the most severe condition for ADGM1304 RON drift over actuations.

SPECIFICATIONS ADDED

V_{DD} = 3.0 V to 3.6V, AGND = 0 V, RFGND = 0 V, all specifications minimum temperature (T_{MIN}) to maximum temperature (T_{MAX}) = 0°C to +85°C, unless otherwise noted.

Table 2.

		Rev D			Rev E				
Parameter	**Symbol**	**Min**	**Typ** [1]	**Max**	**Min**	**Typ** [1]	**Max**	**Unit**	**Test Conditions/Comments**
ON RESISTANCE PROPERTIES [2]									See the ON Resistance (RON) Properties section for details
RELIABILITY PROPERTIES									
Hot Switched									RF power = Continuous Wave (CW), Terminated into 50 Ω.
10dBm							5.16×10^9	Actuations	50 percent of test population failure point (T50)
15dBm							3.21×10^9	Actuations	50 percent of test population failure point (T50)
20dBm							390×10^3	Actuations	50 percent of test population failure point (T50)
DYNAMIC CHARACTERISTICS									
Operating Frequency					0Hz/DC		14	GHz	
Isolation	I_{SO}								
RF1 to RFC						25		dB	At 6 GHz RF2 is on, RF1 is off, testing RF1 to RFC
RF2 to RFC						23		dB	At 6 GHz RF1 is on, RF2 is off, testing RF2 to RFC
Power-Up Time						0.75		ms	C_{CP} = 47 pF, 95% V_{DD} to 90% RFx
Internal Oscillator Feedthrough [3]						−146		dBm/Hz	Spectrum analyzer resolution bandwidth (RBW) = 200 Hz; one switch in on state, all other switches off with 50 Ω terminations [4]
DIGITAL OUTPUTS									
Output High Voltage	V_{OH}				V_{DD} – 0.4 V			V	Source current (I_{SOURCE}) = 1 mA
Output Low Voltage	V_{OL}						0.4	V	Sink current (I_{SINK}) = 1 mA
POWER REQUIREMENTS									
Low Power Mode Current [5]	$I_{DD\ EXT\ VCP}$						50	μA	
External Drive Current	$I_{CP\ EXT\ VCP}$						20	μA	

[1] Typical specifications tested at 25°C with V_{DD} = 3.3 V.
[2] This section is intentionally left blank, for details see the ON Resistance (RON) Properties section for details
[3] Disable the internal oscillator to eliminate feedthrough.
[4] The spectrum analyzer setup is as follows: RBW = 200 Hz, video bandwidth (VBW) = 2 Hz, span = 100 kHz, input attenuator = 0 dB, the detector type is peak, and the maximum hold is off. The fundamental feedthrough noise or harmonic thereof (whichever is higher) is tested.
[5] For more details, see the Low Power Mode section.

SPECIFICATIONS REMOVED

V_{DD} = 3.0 V to 3.6V, AGND = 0 V, RFGND = 0 V, all specifications minimum temperature (T_{MIN}) to maximum temperature (T_{MAX}) = 0°C to +85°C, unless otherwise noted.

Table 3.

		Rev D			Rev E				
Parameter	**Symbol**	**Min**	**Typ** [1]	**Max**	**Min**	**Typ** [1]	**Max**	**Unit**	**Test Conditions/Comments**
DYNAMIC CHARACTERISTICS									
Settling									
Rising Edge			40					µs	50% INx pin to 0.05 dB final IL value, 50 Ω termination
Falling Edge			8					µs	50% INx pin to 0.05 dB final IL value, 50 Ω termination
Wake up			0.55	1.2				ms	C_{CP} = 47 pF; 50% INx pin to 90% RFx pin
SWITCH PROPERTIES									
EXTCLK PROPERTIES									
EXTCLK Input Range		20		23				MHz	
EXTCLK Input High Voltage	EV_{INH}	1.5						V	
EXTCLK Input Low Voltage	EV_{INL}			0.5				V	
EXTCLK Input Current	EI_{INL}/EI_{INH}			±10				µA	$EV_{IN} = EV_{INL}$ or EV_{INH}
POWER REQUIREMENTS									
IDD Sleep Mode Current			1					µA	

[1] Typical specifications tested at 25°C with V_{DD} = 3.3 V.

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise noted.

Table 4.

	Rev D	Rev E
Parameter	**Rating**	**Rating**
V_{DD} to AGND	−0.3 V to +6 V	−0.3 V to +6 V
Digital Inputs [1]	−0.3 V to V_{DD} + 0.3 V or 30 mA (whichever occurs first)	−0.3 V to V_{DD} + 0.3 V or 30 mA (whichever occurs first)
DC Voltage Rating [2]	±10 V	±7 V
Current Rating [2]	250 mA	250 mA
RF Power Rating	37 dBm	37 dBm
Stand Off Voltage [3]		
	100 V (RFC pin)	±10 V (RF_X to AGND)
	20 V (RFx pins)	±10 V (RFC to AGND)
		20 V (RF_X to RFC)
Hot Switching [4]	0 V	0 V
EXTCLK Input Voltage	−0.3 V to V_{DD} + 0.3 V or 30 mA (whichever occurs first)	
Operating Temperature Range	0°C to +85°C	0°C to +85°C
Storage Temperature Range	−65°C to +150°C	−65°C to +150°C
Reflow Soldering (Pb-Free)		
Peak Temperature	260(+0/−5)°C	260(+0/−5)°C
Time at Peak Temperature	10 sec to 30 sec	10 sec to 30 sec
ESD		
Human Body Model (HBM) [5]		
RF1 to RF4 Pins and RFC Pin	100 V	100 V
All Other Pins	2.5 kV	2.5 kV
Field-Induced Charged-Device Model (FICDM) [6]		
All Pins	500 V	500 V
Group D		
Mechanical Shock [7]	1500 *g* with 0.5 ms pulse	1500 *g* with 0.5 ms pulse
Vibration	20 Hz to 2000 Hz acceleration at 50 *g*	20 Hz to 2000 Hz acceleration at 50 *g*
Constant Acceleration	30,000 *g*	30,000 *g*

[1] Clamp overvoltages at INx pin by internal diodes. Limit the current to the maximum ratings given.
[2] This rating is with respect to the switch in the on position with no RF signal applied.
[3] This rating is with respect to the switch in the off position.
[4] Hot switching is not recommended.
[5] Take proper precautions during handling as outlined in the Handling Precautions section.
[6] A safe automated handling and assembly process is achieved at this rating level by implementing industry-standard ESD controls.
[7] If the device is dropped during handling, do not use the device.

PIN CONFIGURATION CHANGES FROM REV.D TO REV.E

Table 5. Pin Configuration Changes

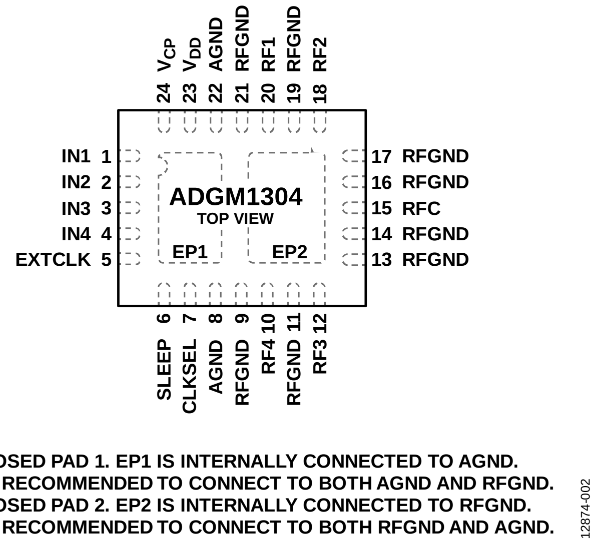
<table>
<tr><th>Rev.D</th><th>Rev.E</th></tr>
<tr><td>


Figure 1 Pin Configuration of ADGM1304 Rev D
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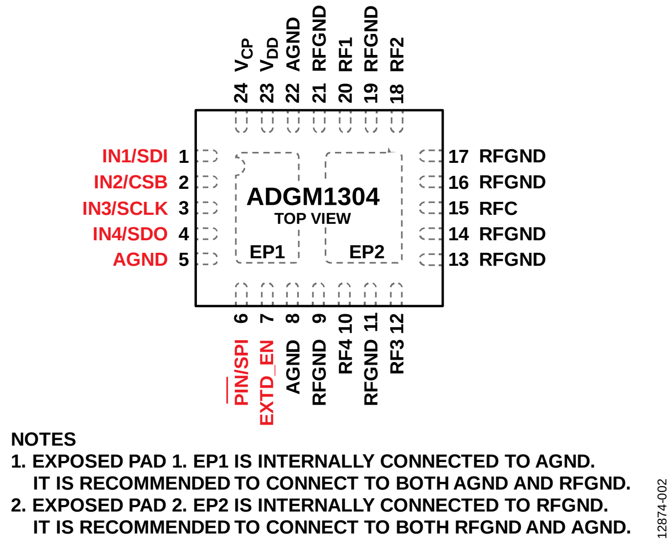

Figure 2 Pin Configuration of ADGM1304 Rev E
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Table 6. Pin Function Descriptions

Pin No.	Rev D Mnemonic	Rev E Mnemonic	Description
1	IN1	IN1/SDI	Parallel Logic Digital Control Input 1/Serial Data Input. The voltage applied to this pin controls the gate of the MEMS switch from RF1 to RFC. In SPI mode, this is the serial data input pin. In parallel mode, if IN1 is low, RF1 to RFC is open (off). If IN1 is high, RF1 to RFC is closed (on).
2	IN2	IN2/CSB	Parallel Logic Digital Control Input 2/Chip Select. The voltage applied to this pin controls the gate of the MEMS switch from RF2 to RFC. In SPI mode, this is the chip select pin. In parallel mode, if IN2 is low, RF2 to RFC is open (off). If IN2 is high, RF2 to RFC is closed (on).
3	IN3	IN3/SCLK	Parallel Logic Digital Control Input 3/Serial Clock. The voltage applied to this pin controls the gate of the MEMS switch from RF3 to RFC. In SPI mode, this is the serial clock pin. In parallel mode, if IN3 is low, RF3 to RFC is open (off). If IN3 is high, RF3 to RFC is closed (on).
4	IN4	IN4/SDO	Parallel Logic Digital Control Input 4/Serial Data Output. The voltage applied to this pin controls the gate of the MEMS switch from RF4 to RFC. In SPI mode, this is the serial data output pin. In parallel mode, if IN4 is low, RF4 to RFC is open (off). If IN4 is high, RF4 to RFC is closed (on).
5	EXTCLK	AGND	Analog Ground Connection.
6	SLEEP	PIN/SPI	Parallel Mode Enable/SPI Mode Enable. The SPI interface is enabled when this pin is high, and the parallel interface (IN1, IN2, IN3, IN4) is enabled when this pin is low.
7	CLKSEL	EXTD_EN	External Voltage Drive Enable. In normal operation, set EXTD_EN low to enable the built in 10 MHz oscillator, which enables the internal charge pump circuitry. Setting EXTD_EN high disables the internal 10 MHz oscillator and the charge pump. With the oscillator disabled, the switch can still be controlled via the logic interface pins (IN1 to IN4) but the VCP pin must to be driven with 80 V dc from an external voltage supply. Disabling the internal oscillator eliminates the associated 10 MHz noise feedthrough into the switch.
8,22	AGND	AGND	Analog Ground Connection.
9, 11, 13, 14, 16, 17, 19, 21	RFGND	RFGND	RF Ground Connection.

	Rev D	Rev E	
Pin No.	Mnemonic	Mnemonic	Description
10	RF4	RF4	RF4 Port. This pin can be an input or an output. If unused, connect this pin to RFGND.
12	RF3	RF3	RF3 Port. This pin can be an input or an output. If unused, connect this pin to RFGND.
15	RFC	RFC	Common RF Port. This pin can be an input or an output.
18	RF2	RF2	RF2 Port. This pin can be an input or an output. If unused, connect this pin to RFGND.
20	RF1	RF1	RF1 Port. This pin can be an input or an output. If unused, connect this pin to RFGND.
23	V_{DD}	V_{DD}	Positive Power Supply Input. The recommended decoupling capacitor to ground value is 0.1uF. For the recommended input voltage for this chip, see the Specifications section.
24	V_{CP}	V_{CP}	Charge Pump Capacitor Terminal. The recommended shunt capacitor to ground value is 47 pF (100V rated). If Pin 7 is high, an 80 V dc drive voltage must be input into VCP to drive the switches.
	EP1	EP1	Exposed Pad 1. EP1 is internally connected to AGND. Connect this pad to AGND or to both AGND and RFGND.
	EP2	EP2	Exposed Pad 2. EP2 is internally connected to RFGND. Connect this pad to RFGND or to both RFGND and AGND.

TYPICAL OPERATING CIRCUIT CHANGES FROM REV.D TO REV.E

ADGM1304 REV D TYPICAL OPERATING CIRCUIT

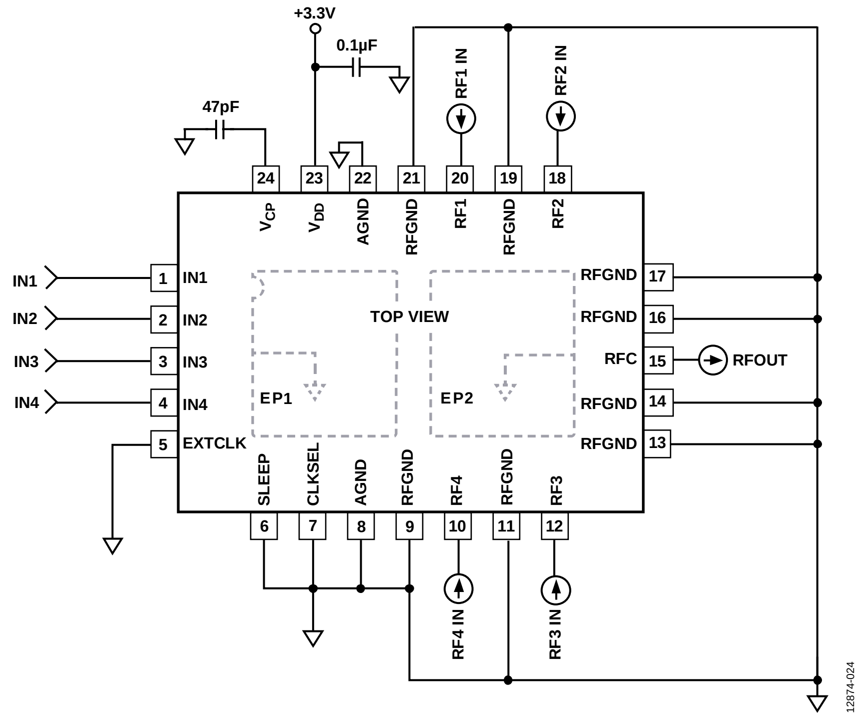
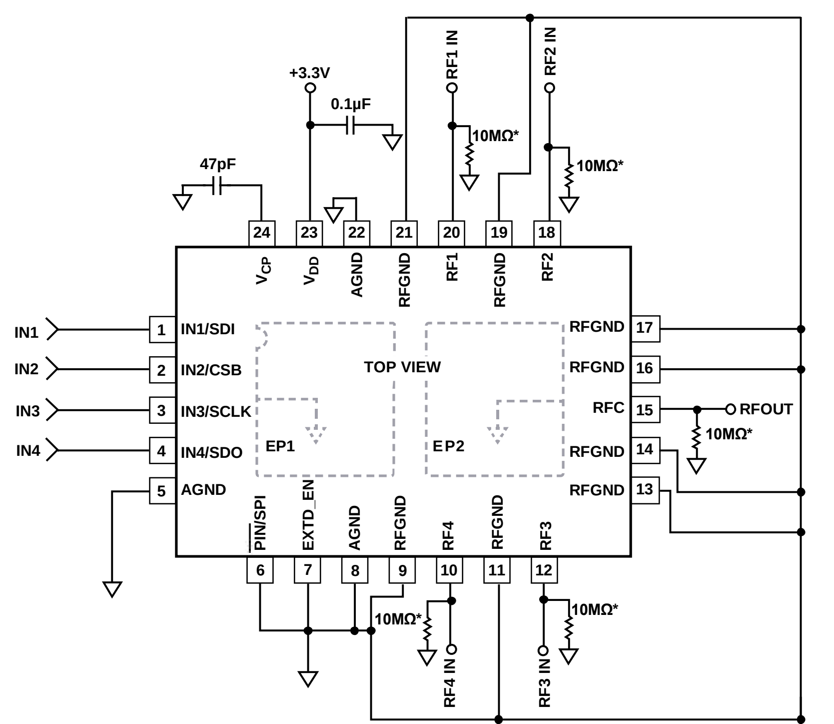


Figure 3 Typical Operating Circuit for ADGM1304 Rev D

ADGM1304 REV E TYPICAL OPERATING CIRCUIT IN PARALLEL MODE



*10MΩ RESISTORS ARE REQUIRED TO AVOID ANY FLOATING NODES.
FOR MORE INFORMATION, REFER TO THE APPLICATIONS INFORMATION SECTION

Figure 4 Typical Operating Circuit in Parallel Mode for ADGM1304 Rev E

ON RESISTANCE (RON) PROPERTIES

The ADGM1304 MEMS switch is fully operational at DC(0Hz). It is recommended to refer to Table 7 which details the DC resistance (RON) performance and RON drift of the switch. Further discussion follows below with important typical performance plots shown. The RON performance of the MEMS switch is affected by part to part variation, channel to channel variation, cycle actuations, settling time post turn on, bias voltage and Temperature changes.

ON RESISTANCE SPECIFICATIONS

V_{DD} = 3.0 V to 3.6, AGND = 0 V, RFGND = 0 V, all specifications minimum temperature (T_{MIN}) to maximum temperature (T_{MAX}) = 0°C to +85°C, after first actuation, unless otherwise noted.

Table 7.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
ON RESISTANCE PROPERTIES						
Initial On Resistance Properties						
On Resistance	RON			2.9	Ω	Drain source current (I_{DS}) = 50 mA, 0 V input bias, at 1 ms
On-Resistance Match Between Channels	ΔRON_{CH_CH}			1	Ω	
On Resistance Drift						
Over Time[1]	ΔRON_{TIME}			−0.25	Ω	RON change from 1 ms to 100 ms after actuation
Over Actuations[2]	ΔRON		0.5		Ω	10^9 actuations, switch is actuated at 25°C and RON is measured at 25°C
				5	Ω	10^9 actuations, switch is actuated at 85°C and RON is measured at 25°C, 1kHz actuating frequency, 220 mA load applied between toggles[3]

[1] Max RON over time is RON (max)+ΔRON_{TIME} (max)= 2.65 Ω
[2] Max RON after 1Billion actuations is RON (max)+ΔRON (max)= 7.9 Ω
[3] Actuating the switch at 85°C and measuring RON at 25°C is the most severe condition for ADGM1304 RON drift over actuations.

APPLICATION IMPACT EXAMPLE

System Error Considerations due to On Resistance Drift

ADGM1304 Ron varies over time and over actuations. In a 50 Ω system, the on-resistance drift over switch actuations can introduce system inaccuracy. Figure 5 shows ADGM1304 connected with the load in a 50 Ω system. The system error caused by ADGM1304 RON drift can be calculated by equation(1)

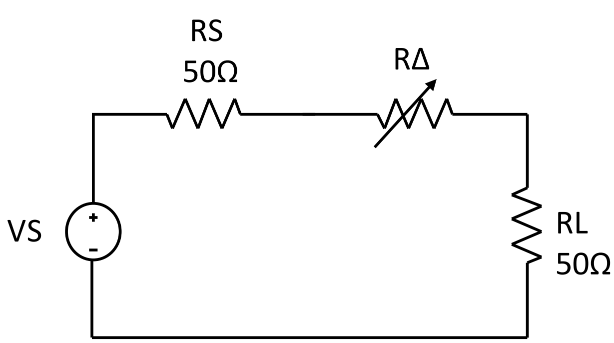


Figure 6 50 Ω system representation where the ADGM1304 is connected with the load

$$\text{System Error (\%)} = R\Delta / RL \quad (1)$$

RΔ = ADGM1304 RON Drift

RL = Load Impedance

RS = Source Impedance

The ADGM1304 RON drift also effects insertion loss which need to be considered. The on-resistance impact on insertion loss can be calculated by the equation (2)

$$\text{Insertion Loss [dB]} = 10 \log (1 + (R\Delta / RL)) \quad (2)$$

Table 8 shows the system error (%) and insertion loss error caused due to ADGM1304 RON drift

Ron Drift (Ω)	System Error (%)	Insertion Loss Error (dB)
4.75	9.5	0.39
5	10	0.41

BOM SET Comparison

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

Package	Amkor BOM			ASE BOM		
	EMC	D/A	Wire	EMC	D/A	Wire
LFCSP	G770HCD	QMI 536 non-conductive	1.3 mils / 2N Au	G700LYT	QMI 536 non-conductive	1.3 mils / 2N Au