

## FEATURES

±2 V to ±6 V dual supply  
 2 V to 12 V single supply  
 <0.1 nA leakage currents (typical)  
 45 Ω typical on resistance over full signal range  
 Rail-to-rail switching operation  
 Single, 8 to 1 multiplexer  
 16-lead TSSOP package  
 0.01 μA typical supply current  
 TTL/CMOS compatible inputs

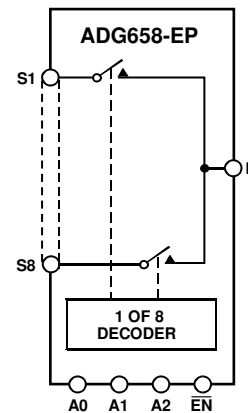
## ENHANCED PRODUCT FEATURES

Supports defense and aerospace applications (AQEC  
 standard)  
 Military temperature range: -55°C to +125°C  
 Controlled manufacturing baseline  
 One assembly/test site  
 One fabrication site  
 Enhanced product change notification  
 Qualification data available on request

## APPLICATIONS

Automatic test equipment  
 Data acquisition systems  
 Battery-powered systems  
 Communication systems  
 Audio and video signal routing  
 Relay replacement  
 Sample-and-hold systems  
 Industrial control systems

## FUNCTIONAL BLOCK DIAGRAM



SWITCHES SHOWN FOR A LOGIC 1 INPUT.

Figure 1.

## GENERAL DESCRIPTION

The ADG658-EP is a low voltage, CMOS analog multiplexer comprised of eight single channels. The ADG658-EP switches one of eight inputs (S1 to S8) to a common output, D, as determined by the 3-bit binary address lines A0, A1, and A2. An  $\overline{\text{EN}}$  input enables or disables the device. When disabled, all channels are switched off.

The ADG658-EP is designed on an enhanced process that provides lower power dissipation yet gives high switching speeds. It can operate equally well as either a multiplexer or a demultiplexer, and has an input range that extends to the supplies. All channels exhibit break-before-make switching action, preventing momentary shorting when switching channels. All digital inputs have +0.8 V to +2.4 V logic thresholds, ensuring TTL/CMOS logic compatibility when using single +5 V or dual ±5 V supplies.

The ADG658-EP is available in a 16-lead TSSOP package.

Additional application and technical information can be found in the [ADG658](#) data sheet.

## PRODUCT HIGHLIGHTS

1. Single-supply and dual-supply operation. The ADG658-EP offers high performance and is fully specified and guaranteed with ±5 V, +5 V, and +3 V supply rails.
2. Military temperature range -55°C to +125°C.
3. Low supply current, typically 0.01 μA.
4. 16-lead TSSOP package.

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**REVISION HISTORY**

**8/2017—Revision 0: Initial Version**

## SPECIFICATIONS

### DUAL SUPPLY

$V_{DD} = 5\text{ V} \pm 10\%$ ,  $V_{SS} = -5\text{ V} \pm 10\%$ ,  $GND = 0\text{ V}$ , unless otherwise noted.

Table 1.

Parameter	+25°C	-55°C to +125°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>				
Analog Signal Range		$V_{SS}$ to $V_{DD}$	V	$V_{DD} = +4.5\text{ V}$ , $V_{SS} = -4.5\text{ V}$
On Resistance, $R_{ON}$	45		$\Omega$ typ	Source voltage ( $V_S$ ) = $\pm 4.5\text{ V}$ , source current ( $I_S$ ) = 1 mA
	75	100	$\Omega$ max	
On Resistance Match Between Channels, $\Delta R_{ON}$	1.3		$\Omega$ typ	$V_S = 3.5\text{ V}$ , $I_S = 1\text{ mA}$
	3	3.5	$\Omega$ max	$V_{DD} = +5\text{ V}$ , $V_{SS} = -5\text{ V}$
On Resistance Flatness, $R_{FLAT(ON)}$	10		$\Omega$ typ	$V_S = \pm 3\text{ V}$ , $I_S = 1\text{ mA}$
	16	18	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>				
Source Off Leakage, $I_S$ (OFF)	$\pm 0.005$		nA typ	$V_{DD} = +5.5\text{ V}$ , $V_{SS} = -5.5\text{ V}$
	$\pm 0.2$	$\pm 5$	nA max	Drain voltage ( $V_D$ ) = $\pm 4.5\text{ V}$ , $V_S = \mp 4.5\text{ V}$
Drain Off Leakage, $I_D$ (OFF)	$\pm 0.005$		nA typ	$V_D = \pm 4.5\text{ V}$ , $V_S = \mp 4.5\text{ V}$
	$\pm 0.2$	$\pm 5$	nA max	
Channel On Leakage $I_D$ , $I_S$ (ON)	$\pm 0.005$		nA typ	$V_D = V_S = \pm 4.5\text{ V}$
	$\pm 0.2$	$\pm 5$	nA max	
<b>DIGITAL INPUTS</b>				
Input High Voltage, $V_{INH}$		2.4	V min	
Input Low Voltage, $V_{INL}$		0.8	V max	
Input Current				
$I_{INL}$ or $I_{INH}$	0.005		$\mu\text{A}$ typ	Input voltage ( $V_{IN}$ ) = $V_{INL}$ or $V_{INH}$
		$\pm 1$	$\mu\text{A}$ max	
Digital Input Capacitance, $C_{IN}$	2		pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>				
Transition Time, $t_{TRANSITION}$	80		ns typ	Load resistance ( $R_L$ ) = 300 $\Omega$ , load capacitance ( $C_L$ ) = 35 pF
	115	165	ns max	$V_S = 3\text{ V}$
$\overline{EN}$ On Time, $t_{ON}(\overline{EN})$	80		ns typ	$R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$
	115	165	ns max	$V_S = 3\text{ V}$
$\overline{EN}$ Off Time, $t_{OFF}(\overline{EN})$	30		ns typ	$R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$
	45	55	ns max	$V_S = 3\text{ V}$
Break-Before-Make Time Delay, $t_{BBM}$	50		ns typ	$R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$
		10	ns min	Source 1 voltage ( $V_{S1}$ ) = 3 V, source 2 voltage ( $V_{S2}$ ) = 3 V
Charge Injection	2		pC typ	$V_S = 0\text{ V}$ , $R_S = 0\ \Omega$
	4		pC max	$C_L = 1\ \text{nF}$
Off Isolation	-90		dB typ	$R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$
Total Harmonic Distortion Plus Noise, THD + N	0.025		% typ	$R_L = 600\ \Omega$ , 2 V p-p, $f = 20\ \text{Hz}$ to 20 kHz
-3 dB Bandwidth	210		MHz typ	$R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$
Source Capacitance, $C_S$ (OFF)	4		pF typ	$f = 1\ \text{MHz}$
Drain Capacitance, $C_D$ (OFF)	23		pF typ	$f = 1\ \text{MHz}$
$C_D$ , $C_S$ (ON)	28		pF typ	$f = 1\ \text{MHz}$
<b>POWER REQUIREMENTS</b>				
Positive Power Supply Current, $I_{DD}$	0.01		$\mu\text{A}$ typ	$V_{DD} = +5.5\text{ V}$ , $V_{SS} = -5.5\text{ V}$
		1	$\mu\text{A}$ max	Digital inputs = 0 V or 5.5 V
Negative Power Supply Current, $I_{SS}$	0.01		$\mu\text{A}$ typ	Digital inputs = 0 V or 5.5 V
		1	$\mu\text{A}$ max	

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

**5 V SINGLE SUPPLY**

$V_{DD} = 5\text{ V} \pm 10\%$ ,  $V_{SS} = 0\text{ V}$ ,  $GND = 0\text{ V}$ , unless otherwise noted.

**Table 2.**

Parameter	+25°C	-55°C to +125°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>				
Analog Signal Range		0 to $V_{DD}$	V	$V_{DD} = 4.5\text{ V}$ , $V_{SS} = 0\text{ V}$
On Resistance, $R_{ON}$	85		$\Omega$ typ	$V_S = 0\text{ V to } 4.5\text{ V}$ , $I_S = 1\text{ mA}$
	150	200	$\Omega$ max	
On Resistance Match Between Channels, $\Delta R_{ON}$	4.5		$\Omega$ typ	$V_S = 3.5\text{ V}$ , $I_S = 1\text{ mA}$
	8	10	$\Omega$ max	
On Resistance Flatness, $R_{FLAT(ON)}$	13	16	$\Omega$ typ	$V_{DD} = 5\text{ V}$ , $V_{SS} = 0\text{ V}$ , $V_S = 1.5\text{ V to } 4\text{ V}$ , $I_S = 1\text{ mA}$
<b>LEAKAGE CURRENTS</b>				
Source Off Leakage, $I_S$ (OFF)	$\pm 0.005$		nA typ	$V_{DD} = 5.5\text{ V}$ $V_S = 1\text{ V}/4.5\text{ V}$ , $V_D = 4.5\text{ V}/1\text{ V}$
	$\pm 0.2$	$\pm 5$	nA max	
Drain Off Leakage, $I_D$ (OFF)	$\pm 0.005$		nA typ	$V_S = 1\text{ V}/4.5\text{ V}$ , $V_D = 4.5\text{ V}/1\text{ V}$
	$\pm 0.2$	$\pm 5$	nA max	
Channel On Leakage $I_D$ , $I_S$ (ON)	$\pm 0.005$		nA typ	$V_S = V_D = 1\text{ V or } 4.5\text{ V}$
	$\pm 0.2$	$\pm 5$	nA max	
<b>DIGITAL INPUTS</b>				
Input High Voltage, $V_{INH}$		2.4	V min	
Input Low Voltage, $V_{INL}$		0.8	V max	
Input Current $I_{INL}$ or $I_{INH}$	0.005		$\mu\text{A}$ typ	$V_{IN} = V_{INL}$ or $V_{INH}$
		$\pm 1$	$\mu\text{A}$ max	
Digital Input Capacitance, $C_{IN}$	2		pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>				
Transition Time, $t_{TRANSITION}$	120		ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	200	300	ns max	$V_S = 3\text{ V}$
$\overline{\text{EN}}$ On Time, $t_{ON}(\overline{\text{EN}})$	120		ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	190	280	ns max	$V_S = 3\text{ V}$
$\overline{\text{EN}}$ Off Time, $t_{OFF}(\overline{\text{EN}})$	35		ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	50	70	ns max	$V_S = 3\text{ V}$
Break-Before-Make Time Delay, $t_{BBM}$	100		ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
		10	ns min	$V_{S1} = V_{S2} = 3\text{ V}$
Charge Injection	0.5		pC typ	$V_S = 2.5\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$
	1		pC max	
Off Isolation	-90		dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$
-3 dB Bandwidth	180		MHz typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$
Source Capacitance, $C_S$ (OFF)	5		pF typ	$f = 1\text{ MHz}$
Drain Capacitance, $C_D$ (OFF)	29		pF typ	$f = 1\text{ MHz}$
$C_D$ , $C_S$ (ON)	30		pF typ	$f = 1\text{ MHz}$
<b>POWER REQUIREMENTS</b>				
Positive Power Supply Current, $I_{DD}$	0.01		$\mu\text{A}$ typ	$V_{DD} = 5.5\text{ V}$ Digital inputs = 0V or 5.5V
		1	$\mu\text{A}$ max	

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

**2.7 V TO 3.6 V SINGLE SUPPLY**

$V_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = 0$  V, GND = 0 V, unless otherwise noted.

**Table 3.**

Parameter	+25°C	-55°C to +125°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>				
Analog Signal Range		0 to $V_{DD}$	V	$V_{DD} = 2.7$ V, $V_{SS} = 0$ V
On Resistance, $R_{ON}$	185		$\Omega$ typ	$V_S = 0$ V to $2.7$ V, $I_S = 0.1$ mA
	300	400	$\Omega$ max	
On Resistance Match Between Channels, $\Delta R_{ON}$	2		$\Omega$ typ	$V_S = 1.5$ V, $I_S = 0.1$ mA
	4.5	7	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>				
Source Off Leakage, $I_S$ (OFF)	$\pm 0.005$		nA typ	$V_{DD} = 3.3$ V
	$\pm 0.2$	$\pm 5$	nA max	$V_S = 1$ V/3 V, $V_D = 3$ V/1 V
Drain Off Leakage, $I_D$ (OFF)	$\pm 0.005$		nA typ	$V_S = 1$ V/3 V, $V_D = 3$ V/1 V
	$\pm 0.2$	$\pm 5$	nA max	
Channel On Leakage $I_D, I_S$ (ON)	$\pm 0.005$		nA typ	$V_S = V_D = 1$ V or 3 V
	$\pm 0.2$	$\pm 5$	nA max	
<b>DIGITAL INPUTS</b>				
Input High Voltage, $V_{INH}$		2.0	V min	
Input Low Voltage, $V_{INL}$		0.5	V max	
Input Current				
$I_{INL}$ or $I_{INH}$	0.005		$\mu$ A typ	$V_{IN} = V_{INL}$ or $V_{INH}$
		$\pm 1$	$\mu$ A max	
Digital Input Capacitance, $C_{IN}$	2		pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>				
Transition Time, $t_{TRANSITION}$	200		ns typ	$R_L = 300$ $\Omega$ , $C_L = 35$ pF
	370	490	ns max	$V_S = 1.5$ V
$\overline{EN}$ On Time, $t_{ON}(\overline{EN})$	230		ns typ	$R_L = 300$ $\Omega$ , $C_L = 35$ pF
	370	490	ns max	$V_S = 1.5$ V
$\overline{EN}$ Off Time, $t_{OFF}(\overline{EN})$	50		ns typ	$R_L = 300$ $\Omega$ , $C_L = 35$ pF
	80	110	ns max	$V_S = 1.5$ V
Break-Before-Make Time Delay, $t_{BBM}$	200		ns typ	$R_L = 300$ $\Omega$ , $C_L = 35$ pF
		10	ns min	$V_{S1} = V_{S2} = 1.5$ V
Charge Injection	1		pC typ	$V_S = 1.5$ V, $R_S = 0$ $\Omega$ , $C_L = 1$ nF
	2		pC max	
Off Isolation	-90		dB typ	$R_L = 50$ $\Omega$ , $C_L = 5$ pF, $f = 1$ MHz
-3 dB Bandwidth	160		MHz typ	$R_L = 50$ $\Omega$ , $C_L = 5$ pF
Source Capacitance, $C_S$ (OFF)	5		pF typ	$f = 1$ MHz
Drain Capacitance, $C_D$ (OFF)	29		pF typ	$f = 1$ MHz
$C_D, C_S$ (ON)	30		pF typ	$f = 1$ MHz
<b>POWER REQUIREMENTS</b>				
Positive Power Supply Current, $I_{DD}$	0.01		$\mu$ A typ	$V_{DD} = 3.6$ V
		1	$\mu$ A max	Digital inputs = 0 V or 3.6 V

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

## ABSOLUTE MAXIMUM RATINGS

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

Table 4.

Parameter	Rating
$V_{DD}$ to $V_{SS}$	13 V
$V_{DD}$ to GND	-0.3 V to +13 V
$V_{SS}$ to GND	+0.3 V to -6.5 V
Analog Inputs <sup>1</sup>	$V_{SS} - 0.3 \text{ V}$ to $V_{DD} + 0.3 \text{ V}$
Digital Inputs <sup>1</sup>	GND - 0.3 V to $V_{DD} + 0.3 \text{ V}$ or 10 mA, whichever occurs first
Peak Current, Sx or D (Pulsed at 1 ms, 10% duty cycle max)	40 mA
Continuous Current, Sx or D	20 mA
Operating Temperature Range	-55°C to +125°C
Storage Temperature Range	-65°C to +150°C
Junction Temperature	150°C
$\theta_{JA}$ Thermal Impedance 16-Lead TSSOP	150.4°C/W
Lead Temperature, Soldering Vapor Phase (60 sec)	215°C
Infrared (15 sec)	220°C
ESD (Human Body Model)	4.0 kV

<sup>1</sup> Overvoltages at  $A_x$ ,  $\overline{EN}$ , Sx, or D are clamped by internal diodes. Current must be limited to the maximum ratings.

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.

Table 5. Truth Table

A2	A1	A0	$\overline{EN}$	Switch Condition
X <sup>1</sup>	X <sup>1</sup>	X <sup>1</sup>	1	None
0	0	0	0	1
0	0	1	0	2
0	1	0	0	3
0	1	1	0	4
1	0	0	0	5
1	0	1	0	6
1	1	0	0	7
1	1	1	0	8

<sup>1</sup> X means don't care

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

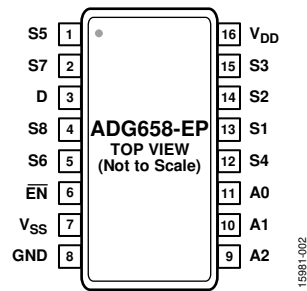


Figure 2. 16-Lead TSSOP Pin Configuration

Table 6. 16-Lead TSSOP Pin Function Descriptions

Pin No.	Mnemonic	Description
1, 2, 4, 5, 12, 13, 14, 15	S1 to S8	Source Terminals. Can be an input or output.
3	D	Drain Terminal. Can be an input or output.
6	$\overline{\text{EN}}$	Active Low Digital Input. When high, device is disabled and all switches are off. When low, Ax logic inputs determine on switch.
7	V <sub>SS</sub>	Most Negative Power Supply Potential.
8	GND	Ground (0 V) Reference.
9, 10, 11	A0 to A2	Logic Control Inputs.
16	V <sub>DD</sub>	Most Positive Power Supply Potential.

TYPICAL PERFORMANCE CHARACTERISTICS

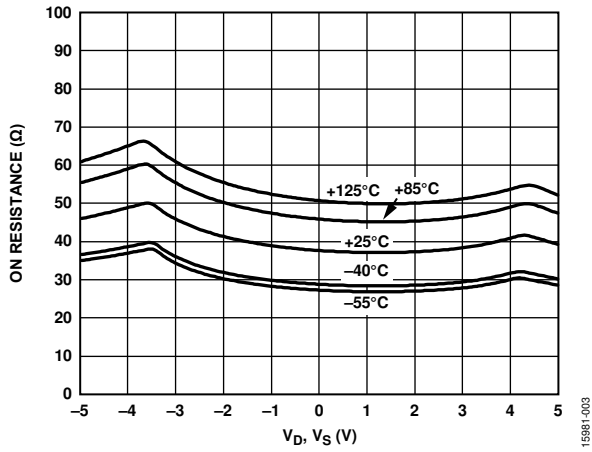


Figure 3. On Resistance vs.  $V_D$ ,  $V_S$  (V) for Different Temperatures (Dual Supply)

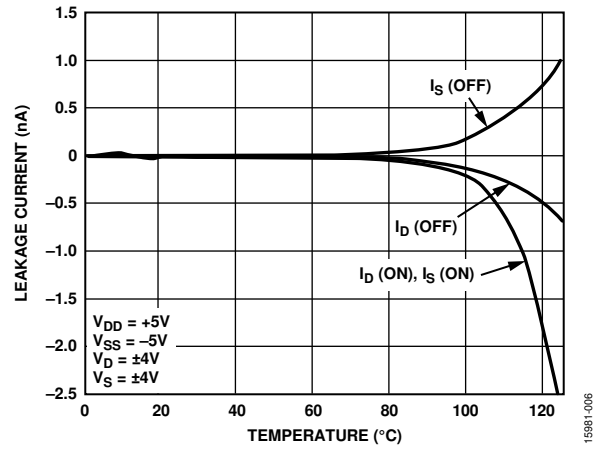


Figure 6. Leakage Current vs. Temperature (Dual Supply)

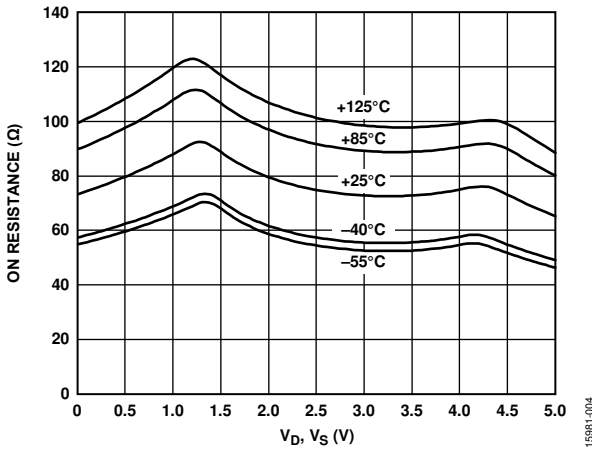


Figure 4. On Resistance vs.  $V_D$ ,  $V_S$  (V) for Different Temperatures (Single Supply)

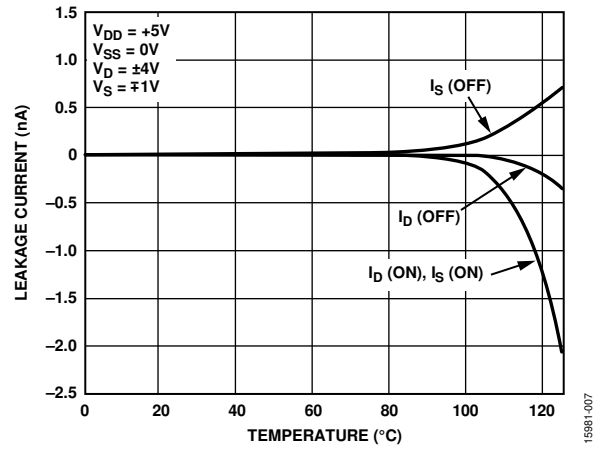


Figure 7. Leakage Current vs. Temperature (Single Supply)

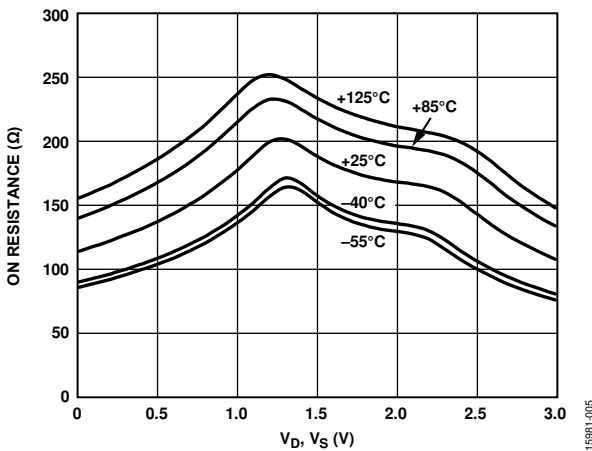


Figure 5. On Resistance vs.  $V_D$ ,  $V_S$  (V) for Different Temperatures (Single Supply)



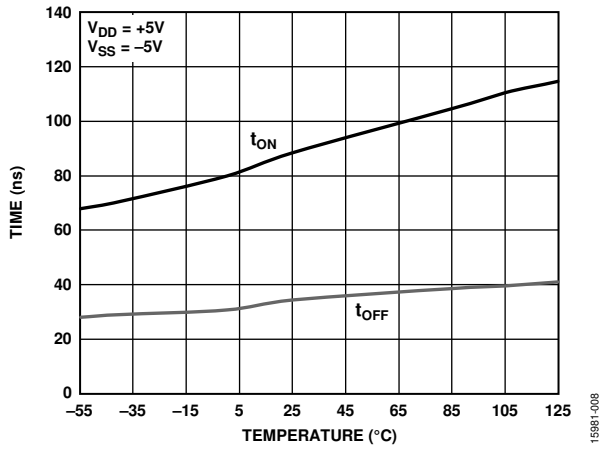


Figure 8.  $t_{ON}/t_{OFF}$  Time vs. Temperature (Dual Supply)

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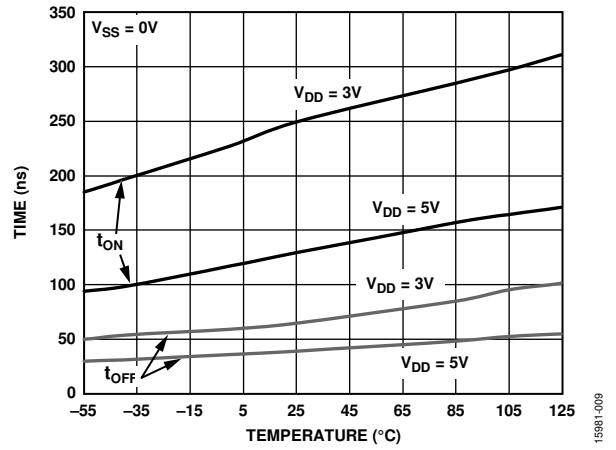
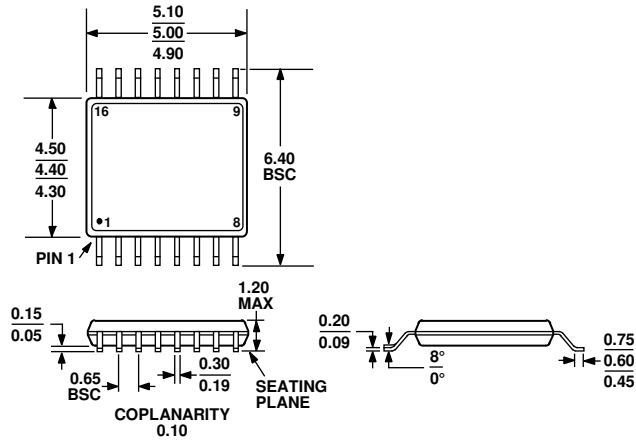


Figure 9.  $t_{ON}/t_{OFF}$  Time vs. Temperature (Single Supply)

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OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-153-AB

Figure 10. 16-Lead Thin Shrink Small Outline Package [TSSOP] (RU-16)

Dimensions shown in millimeters

ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option
ADG658TRUZ-EP	-55°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16
ADG658TRUZ-EP-RL7	-55°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16

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