Quad-Channel Digital Isolators
ADuM1400/ADuM1401/ADuM1402

FEATURES

Low power operation
    5 V operation
        1.0 mA per channel max @ 0 Mbps to 2 Mbps
        3.5 mA per channel max @ 10 Mbps
        31 mA per channel max @ 90 Mbps
    3 V operation
        0.7 mA per channel max @ 0 Mbps to 2 Mbps
        2.1 mA per channel max @ 10 Mbps
        20 mA per channel max @ 90 Mbps
Bidirectional communication
3 V/5 V level translation
High temperature operation: 105°C
High data rate: dc to 90 Mbps (NRZ)
Precise timing characteristics
    2 ns max pulse width distortion
    2 ns max channel-to-channel matching
High common-mode transient immunity: >25 kV/µs
Output enable function
16-lead SOIC wide body package, Pb-free models available
Safety and regulatory approvals
    UL recognition: 2500 V rms for 1 minute per UL 1577
    CSA component acceptance notice #5A
    VDE certificate of conformity
        DIN EN 60747-5-2 (VDE 0884 Part 2): 2003-01
        DIN EN 60950 (VDE 0805): 2001-12; EN 60950: 2000
        V_{IORM} = 560 V peak
    TÜV approval: IEC/EN/UL/CSA 61010-1

APPLICATIONS

General-purpose multichannel isolation
SPI® interface/data converter isolation
RS-232/RS-422/RS-485 transceiver
Industrial field bus isolation

GENERAL DESCRIPTION

The ADuM140x[1] are 4-channel digital isolators based on Analog Devices' *i*Coupler® technology. Combining high speed CMOS and monolithic air core transformer technology, these isolation components provide outstanding performance characteristics superior to alternatives such as optocoupler devices.

By avoiding the use of LEDs and photodiodes, *i*Coupler devices remove the design difficulties commonly associated with optocouplers. The typical optocoupler concerns regarding uncertain current transfer ratios, nonlinear transfer functions, and temperature and lifetime effects are eliminated with the simple *i*Coupler digital interfaces and stable performance characteristics. The need for external drivers and other discrete components is eliminated with these *i*Coupler products. Furthermore, *i*Coupler devices consume one-tenth to one-sixth the power of optocouplers at comparable signal data rates.

The ADuM140x isolators provide four independent isolation channels in a variety of channel configurations and data rates (see the Ordering Guide). All models operate with the supply voltage on either side ranging from 2.7 V to 5.5 V, providing compatibility with lower voltage systems as well as enabling a voltage translation functionality across the isolation barrier. In addition, the ADuM140x provides low pulse width distortion (<2 ns for CRW grade) and tight channel-to-channel matching (<2 ns for CRW grade). Unlike other optocoupler alternatives, the ADuM140x isolators have a patented refresh feature that ensures dc correctness in the absence of input logic transitions and during power-up/power-down conditions.

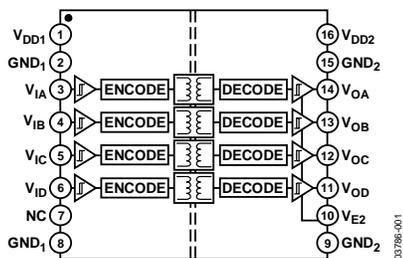[1] Protected by U.S. Patents 5,952,849 and 6,873,065. Other patents pending.

FUNCTIONAL BLOCK DIAGRAMS

Figure 1. ADuM1400 Functional Block Diagram
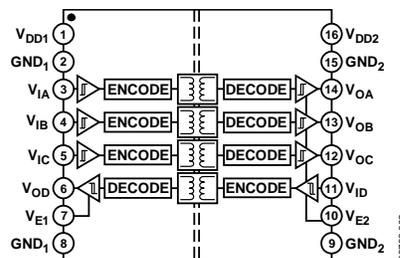
Figure 2. ADuM1401 Functional Block Diagram
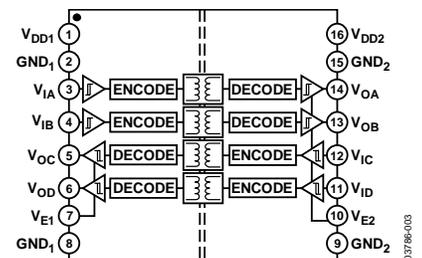
Figure 3. ADuM1402 Functional Block Diagram

Rev. D

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SPECIFICATIONS

ELECTRICAL CHARACTERISTICS—5 V OPERATION[1]

$4.5 \text{ V} \leq V_{DD1} \leq 5.5 \text{ V}$, $4.5 \text{ V} \leq V_{DD2} \leq 5.5 \text{ V}$; all min/max specifications apply over the entire recommended operation range, unless otherwise noted; all typical specifications are at $T_A = 25°C$, $V_{DD1} = V_{DD2} = 5 \text{ V}$.

Table 1.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
DC SPECIFICATIONS						
Input Supply Current per Channel, Quiescent	$I_{DDI (Q)}$		0.50	0.53	mA	
Output Supply Current per Channel, Quiescent	$I_{DDO (Q)}$		0.19	0.21	mA	
ADuM1400, Total Supply Current, Four Channels[2]						
DC to 2 Mbps						
V_{DD1} Supply Current	$I_{DD1 (Q)}$		2.2	2.8	mA	DC to 1 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (Q)}$		0.9	1.4	mA	DC to 1 MHz logic signal freq.
10 Mbps (BRW and CRW Grades Only)						
V_{DD1} Supply Current	$I_{DD1 (10)}$		8.6	10.6	mA	5 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (10)}$		2.6	3.5	mA	5 MHz logic signal freq.
90 Mbps (CRW Grade Only)						
V_{DD1} Supply Current	$I_{DD1 (90)}$		70	100	mA	45 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (90)}$		18	25	mA	45 MHz logic signal freq.
ADuM1401, Total Supply Current, Four Channels[2]						
DC to 2 Mbps						
V_{DD1} Supply Current	$I_{DD1 (Q)}$		1.8	2.4	mA	DC to 1 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (Q)}$		1.2	1.8	mA	DC to 1 MHz logic signal freq.
10 Mbps (BRW and CRW Grades Only)						
V_{DD1} Supply Current	$I_{DD1 (10)}$		7.1	9.0	mA	5 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (10)}$		4.1	5.0	mA	5 MHz logic signal freq.
90 Mbps (CRW Grade Only)						
V_{DD1} Supply Current	$I_{DD1 (90)}$		57	82	mA	45 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (90)}$		31	43	mA	45 MHz logic signal freq.
ADuM1402, Total Supply Current, Four Channels[2]						
DC to 2 Mbps						
V_{DD1} or V_{DD2} Supply Current	$I_{DD1 (Q)}$, $I_{DD2 (Q)}$		1.5	2.1	mA	DC to 1 MHz logic signal freq.
10 Mbps (BRW and CRW Grades Only)						
V_{DD1} or V_{DD2} Supply Current	$I_{DD1 (10)}$, $I_{DD2 (10)}$		5.6	7.0	mA	5 MHz logic signal freq.
90 Mbps (CRW Grade Only)						
V_{DD1} or V_{DD2} Supply Current	$I_{DD1 (90)}$, $I_{DD2 (90)}$		44	62	mA	45 MHz logic signal freq.
For All Models						
Input Currents	I_{IA}, I_{IB}, I_{IC}, I_{ID}, I_{E1}, I_{E2}	−10	+0.01	+10	μA	$0 \leq V_{IA}, V_{IB}, V_{IC}, V_{ID} \leq V_{DD1}$ or V_{DD2}, $0 \leq V_{E1}, V_{E2} \leq V_{DD1}$ or V_{DD2}
Logic High Input Threshold	V_{IH}, V_{EH}	2.0			V	
Logic Low Input Threshold	V_{IL}, V_{EL}			0.8	V	
Logic High Output Voltages	V_{OAH}, V_{OBH}, V_{OCH}, V_{ODH}	$V_{DD1}, V_{DD2} − 0.1$	5.0		V	$I_{Ox} = −20 \text{ μA}$, $V_{Ix} = V_{IxH}$
		$V_{DD1}, V_{DD2} − 0.4$	4.8		V	$I_{Ox} = −4 \text{ mA}$, $V_{Ix} = V_{IxH}$
Logic Low Output Voltages	V_{OAL}, V_{OBL}, V_{OCL}, V_{ODL}		0.0	0.1	V	$I_{Ox} = 20 \text{ μA}$, $V_{Ix} = V_{IxL}$
			0.04	0.1	V	$I_{Ox} = 400 \text{ μA}$, $V_{Ix} = V_{IxL}$
			0.2	0.4	V	$I_{Ox} = 4 \text{ mA}$, $V_{Ix} = V_{IxL}$

ADuM1400/ADuM1401/ADuM1402

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
SWITCHING SPECIFICATIONS						
ADuM140xARW						
Minimum Pulse Width[3]	PW			1000	ns	C_L = 15 pF, CMOS signal levels
Maximum Data Rate[4]		1			Mbps	C_L = 15 pF, CMOS signal levels
Propagation Delay[5]	t_{PHL}, t_{PLH}	50	65	100	ns	C_L = 15 pF, CMOS signal levels
Pulse Width Distortion, $\lvert t_{PLH} - t_{PHL} \rvert$[5]	PWD			40	ns	C_L = 15 pF, CMOS signal levels
Propagation Delay Skew[6]	t_{PSK}			50	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching[7]	$t_{PSKCD/OD}$			50	ns	C_L = 15 pF, CMOS signal levels
ADuM140xBRW						
Minimum Pulse Width[3]	PW			100	ns	C_L = 15 pF, CMOS signal levels
Maximum Data Rate[4]		10			Mbps	C_L = 15 pF, CMOS signal levels
Propagation Delay[5]	t_{PHL}, t_{PLH}	20	32	50	ns	C_L = 15 pF, CMOS signal levels
Pulse Width Distortion, $\lvert t_{PLH} - t_{PHL} \rvert$[5]	PWD			3	ns	C_L = 15 pF, CMOS signal levels
Change vs. Temperature			5		ps/°C	C_L = 15 pF, CMOS signal levels
Propagation Delay Skew[6]	t_{PSK}			15	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Codirectional Channels[7]	t_{PSKCD}			3	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Opposing-Directional Channels[7]	t_{PSKOD}			6	ns	C_L = 15 pF, CMOS signal levels
ADuM140xCRW						
Minimum Pulse Width[3]	PW		8.3	11.1	ns	C_L = 15 pF, CMOS signal levels
Maximum Data Rate[4]		90	120		Mbps	C_L = 15 pF, CMOS signal levels
Propagation Delay[5]	t_{PHL}, t_{PLH}	18	27	32	ns	C_L = 15 pF, CMOS signal levels
Pulse Width Distortion, $\lvert t_{PLH} - t_{PHL} \rvert$[5]	PWD		0.5	2	ns	C_L = 15 pF, CMOS signal levels
Change vs. Temperature			3		ps/°C	C_L = 15 pF, CMOS signal levels
Propagation Delay Skew[6]	t_{PSK}			10	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Codirectional Channels[7]	t_{PSKCD}			2	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Opposing-Directional Channels[7]	t_{PSKOD}			5	ns	C_L = 15 pF, CMOS signal levels
For All Models						
Output Disable Propagation Delay (High/Low to High Impedance)	t_{PHZ}, t_{PLH}		6	8	ns	C_L = 15 pF, CMOS signal levels
Output Enable Propagation Delay (High Impedance to High/Low	t_{PZH}, t_{PZL}		6	8	ns	C_L = 15 pF, CMOS signal levels
Output Rise/Fall Time (10% to 90%)	t_R/t_F		2.5		ns	C_L = 15 pF, CMOS signal levels
Common-Mode Transient Immunity at Logic High Output[8]	$\lvert CM_H \rvert$	25	35		kV/µs	V_{Ix} = V_{DD1}/V_{DD2}, V_{CM} = 1000 V, transient magnitude = 800 V
Common-Mode Transient Immunity at Logic Low Output[8]	$\lvert CM_L \rvert$	25	35		kV/µs	V_{Ix} = 0 V, V_{CM} = 1000 V, transient magnitude = 800 V
Refresh Rate	f_r		1.2		Mbps	
Input Dynamic Supply Current per Channel[9]	$I_{DDI (D)}$		0.19		mA/Mbps	
Output Dynamic Supply Current per Channel[9]	$I_{DDO (D)}$		0.05		mA/Mbps	

[1] All voltages are relative to their respective ground.

[2] The supply current values for all four channels are combined when running at identical data rates. Output supply current values are specified with no output load present. The supply current associated with an individual channel operating at a given data rate may be calculated as described in the Power Consumption section. See Figure 8 through Figure 10 for information on per-channel supply current as a function of data rate for unloaded and loaded conditions. See Figure 11 through Figure 15 for total V_{DD1} and V_{DD2} supply currents as a function of data rate for ADuM1400/ADuM1401/ADuM1402 channel configurations.

[3] The minimum pulse width is the shortest pulse width at which the specified pulse width distortion is guaranteed.

[4] The maximum data rate is the fastest data rate at which the specified pulse width distortion is guaranteed.

[5] t_{PHL} propagation delay is measured from the 50% level of the falling edge of the V_{Ix} signal to the 50% level of the falling edge of the V_{Ox} signal. t_{PLH} propagation delay is measured from the 50% level of the rising edge of the V_{Ix} signal to the 50% level of the rising edge of the V_{Ox} signal.

[6] t_{PSK} is the magnitude of the worst-case difference in t_{PHL} or t_{PLH} that is measured between units at the same operating temperature, supply voltages, and output load within the recommended operating conditions.

[7] Codirectional channel-to-channel matching is the absolute value of the difference in propagation delays between any two channels with inputs on the same side of the isolation barrier. Opposing-directional channel-to-channel matching is the absolute value of the difference in propagation delays between any two channels with inputs on opposing sides of the isolation barrier.

[8] CM_H is the maximum common-mode voltage slew rate that can be sustained while maintaining $V_O > 0.8\ V_{DD2}$. CM_L is the maximum common-mode voltage slew rate that can be sustained while maintaining $V_O < 0.8\ V$. The common-mode voltage slew rates apply to both rising and falling common-mode voltage edges. The transient magnitude is the range over which the common mode is slewed.

[9] Dynamic supply current is the incremental amount of supply current required for a 1 Mbps increase in signal data rate. See Figure 8 through Figure 10 for information on per-channel supply current for unloaded and loaded conditions. See the Power Consumption section for guidance on calculating the per-channel supply current for a given data rate.

ELECTRICAL CHARACTERISTICS—3 V OPERATION[1]

2.7 V ≤ V_{DD1} ≤ 3.6 V, 2.7 V ≤ V_{DD2} ≤ 3.6 V; all min/max specifications apply over the entire recommended operation range, unless otherwise noted; all typical specifications are at T_A = 25°C, V_{DD1} = V_{DD2} = 3.0 V.

Table 2.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
DC SPECIFICATIONS						
Input Supply Current per Channel, Quiescent	$I_{DDI (Q)}$		0.26	0.31	mA	
Output Supply Current per Channel, Quiescent	$I_{DDO (Q)}$		0.11	0.14	mA	
ADuM1400, Total Supply Current, Four Channels[2]						
DC to 2 Mbps						
V_{DD1} Supply Current	$I_{DD1 (Q)}$		1.2	1.9	mA	DC to 1 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (Q)}$		0.5	0.9	mA	DC to 1 MHz logic signal freq.
10 Mbps (BRW and CRW Grades Only)						
V_{DD1} Supply Current	$I_{DD1 (10)}$		4.5	6.5	mA	5 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (10)}$		1.4	2.0	mA	5 MHz logic signal freq.
90 Mbps (CRW Grade Only)						
V_{DD1} Supply Current	$I_{DD1 (90)}$		37	65	mA	45 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (90)}$		11	15	mA	45 MHz logic signal freq.
ADuM1401, Total Supply Current, Four Channels[2]						
DC to 2 Mbps						
V_{DD1} Supply Current	$I_{DD1 (Q)}$		1.0	1.6	mA	DC to 1 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (Q)}$		0.7	1.2	mA	DC to 1 MHz logic signal freq.
10 Mbps (BRW and CRW Grades Only)						
V_{DD1} Supply Current	$I_{DD1 (10)}$		3.7	5.4	mA	5 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (10)}$		2.2	3.0	mA	5 MHz logic signal freq.
90 Mbps (CRW Grade Only)						
V_{DD1} Supply Current	$I_{DD1 (90)}$		30	52	mA	45 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (90)}$		18	27	mA	45 MHz logic signal freq.
ADuM1402, Total Supply Current, Four Channels[2]						
DC to 2 Mbps						
V_{DD1} or V_{DD2} Supply Current	$I_{DD1 (Q)}$, $I_{DD2 (Q)}$		0.9	1.5	mA	DC to 1 MHz logic signal freq.
10 Mbps (BRW and CRW Grades Only)						
V_{DD1} or V_{DD2} Supply Current	$I_{DD1 (10)}$, $I_{DD2 (10)}$		3.0	4.2	mA	5 MHz logic signal freq.
90 Mbps (CRW Grade Only)						
V_{DD1} or V_{DD2} Supply Current	$I_{DD1 (90)}$, $I_{DD2 (90)}$		24	39	mA	45 MHz logic signal freq.
For All Models						
Input Currents	I_{IA}, I_{IB}, I_{IC}, I_{ID}, I_{E1}, I_{E2}	−10	+0.01	+10	µA	0 ≤ V_{IA}, V_{IB}, V_{IC}, V_{ID} ≤ V_{DD1} or V_{DD2}, 0 ≤ V_{E1}, V_{E2} ≤ V_{DD1} or V_{DD2}
Logic High Input Threshold	V_{IH}, V_{EH}	1.6			V	
Logic Low Input Threshold	V_{IL}, V_{EL}			0.4	V	
Logic High Output Voltages	V_{OAH}, V_{OBH}, V_{OCH}, V_{ODH}	V_{DD1}, V_{DD2} − 0.1	3.0		V	I_{Ox} = −20 µA, V_{Ix} = V_{IxH}
		V_{DD1}, V_{DD2} − 0.4	2.8		V	I_{Ox} = −4 mA, V_{Ix} = V_{IxH}
Logic Low Output Voltages	V_{OAL}, V_{OBL}, V_{OCL}, V_{ODL}		0.0	0.1	V	I_{Ox} = 20 µA, V_{Ix} = V_{IxL}
			0.04	0.1	V	I_{Ox} = 400 µA, V_{Ix} = V_{IxL}
			0.2	0.4	V	I_{Ox} = 4 mA, V_{Ix} = V_{IxL}
SWITCHING SPECIFICATIONS						
ADuM140xARW						
Minimum Pulse Width[3]	PW			1000	ns	C_L = 15 pF, CMOS signal levels
Maximum Data Rate[4]		1			Mbps	C_L = 15 pF, CMOS signal levels
Propagation Delay[5]	t_{PHL}, t_{PLH}	50	75	100	ns	C_L = 15 pF, CMOS signal levels
Pulse Width Distortion, |t_{PLH} − t_{PHL}|[5]	PWD			40	ns	C_L = 15 pF, CMOS signal levels
Propagation Delay Skew[6]	t_{PSK}			50	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching[7]	$t_{PSKCD/OD}$			50	ns	C_L = 15 pF, CMOS signal levels

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
ADuM140xBRW						
Minimum Pulse Width[3]	PW			100	ns	C_L = 15 pF, CMOS signal levels
Maximum Data Rate[4]		10			Mbps	C_L = 15 pF, CMOS signal levels
Propagation Delay[5]	t_{PHL}, t_{PLH}	20	38	50	ns	C_L = 15 pF, CMOS signal levels
Pulse Width Distortion, $|t_{PLH} - t_{PHL}|$[5]	PWD			3	ns	C_L = 15 pF, CMOS signal levels
Change vs. Temperature			5		ps/°C	C_L = 15 pF, CMOS signal levels
Propagation Delay Skew[6]	t_{PSK}			22	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Codirectional Channels[7]	t_{PSKCD}			3	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Opposing-Directional Channels[7]	t_{PSKOD}			6	ns	C_L = 15 pF, CMOS signal levels
ADuM140xCRW						
Minimum Pulse Width[3]	PW		8.3	11.1	ns	C_L = 15 pF, CMOS signal levels
Maximum Data Rate[4]		90	120		Mbps	C_L = 15 pF, CMOS signal levels
Propagation Delay[5]	t_{PHL}, t_{PLH}	20	34	45	ns	C_L = 15 pF, CMOS signal levels
Pulse Width Distortion, $|t_{PLH} - t_{PHL}|$[5]	PWD		0.5	2	ns	C_L = 15 pF, CMOS signal levels
Change vs. Temperature			3		ps/°C	C_L = 15 pF, CMOS signal levels
Propagation Delay Skew[6]	t_{PSK}			16	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Codirectional Channels[7]	t_{PSKCD}			2	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Opposing-Directional Channels[7]	t_{PSKOD}			5	ns	C_L = 15 pF, CMOS signal levels
For All Models						
Output Disable Propagation Delay (High/Low to High Impedance)	t_{PHZ}, t_{PLH}		6	8	ns	C_L = 15 pF, CMOS signal levels
Output Enable Propagation Delay (High Impedance to High/Low)	t_{PZH}, t_{PZL}		6	8	ns	C_L = 15 pF, CMOS signal levels
Output Rise/Fall Time (10% to 90%)	t_R/t_F		3		ns	C_L = 15 pF, CMOS signal levels
Common-Mode Transient Immunity at Logic High Output[8]	$|CM_H|$	25	35		kV/µs	$V_{Ix} = V_{DD1}/V_{DD2}$, V_{CM} = 1000 V, transient magnitude = 800 V
Common-Mode Transient Immunity at Logic Low Output[8]	$|CM_L|$	25	35		kV/µs	V_{Ix} = 0 V, V_{CM} = 1000 V, transient magnitude = 800 V
Refresh Rate	f_r		1.1		Mbps	
Input Dynamic Supply Current per Channel[9]	$I_{DDI (D)}$		0.10		mA/Mbps	
Output Dynamic Supply Current per Channel[9]	$I_{DDO (D)}$		0.03		mA/Mbps	

[1] All voltages are relative to their respective ground.

[2] The supply current values for all four channels are combined when running at identical data rates. Output supply current values are specified with no output load present. The supply current associated with an individual channel operating at a given data rate may be calculated as described in the Power Consumption section. See Figure 8 through Figure 10 for information on per-channel supply current as a function of data rate for unloaded and loaded conditions. See Figure 11 through Figure 15 for total V_{DD1} and V_{DD2} supply currents as a function of data rate for ADuM1400/ADuM1401/ADuM1402 channel configurations.

[3] The minimum pulse width is the shortest pulse width at which the specified pulse width distortion is guaranteed.

[4] The maximum data rate is the fastest data rate at which the specified pulse width distortion is guaranteed.

[5] t_{PHL} propagation delay is measured from the 50% level of the falling edge of the V_{Ix} signal to the 50% level of the falling edge of the V_{Ox} signal. t_{PLH} propagation delay is measured from the 50% level of the rising edge of the V_{Ix} signal to the 50% level of the rising edge of the V_{Ox} signal.

[6] t_{PSK} is the magnitude of the worst-case difference in t_{PHL} or t_{PLH} that is measured between units at the same operating temperature, supply voltages, and output load within the recommended operating conditions.

[7] Codirectional channel-to-channel matching is the absolute value of the difference in propagation delays between any two channels with inputs on the same side of the isolation barrier. Opposing-directional channel-to-channel matching is the absolute value of the difference in propagation delays between any two channels with inputs on opposing sides of the isolation barrier.

[8] CM_H is the maximum common-mode voltage slew rate that can be sustained while maintaining $V_O > 0.8$ V_{DD2}. CM_L is the maximum common-mode voltage slew rate that can be sustained while maintaining $V_O < 0.8$ V. The common-mode voltage slew rates apply to both rising and falling common-mode voltage edges. The transient magnitude is the range over which the common mode is slewed.

[9] Dynamic supply current is the incremental amount of supply current required for a 1 Mbps increase in signal data rate. See Figure 8 through Figure 10 for information on per-channel supply current for unloaded and loaded conditions. See the Power Consumption section for guidance on calculating the per-channel supply current for a given data rate.

ELECTRICAL CHARACTERISTICS—MIXED 5 V/3 V OR 3 V/5 V OPERATION[1]

5 V/3 V operation: $4.5 \text{ V} \leq V_{DD1} \leq 5.5 \text{ V}$, $2.7 \text{ V} \leq V_{DD2} \leq 3.6 \text{ V}$; 3 V/5 V operation: $2.7 \text{ V} \leq V_{DD1} \leq 3.6 \text{ V}$, $4.5 \text{ V} \leq V_{DD2} \leq 5.5 \text{ V}$; all min/max specifications apply over the entire recommended operation range, unless otherwise noted; all typical specifications are at $T_A = 25°C$; $V_{DD1} = 3.0 \text{ V}$, $V_{DD2} = 5 \text{ V}$ or $V_{DD1} = 5 \text{ V}$, $V_{DD2} = 3.0 \text{ V}$.

Table 3.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
DC SPECIFICATIONS						
Input Supply Current per Channel, Quiescent	$I_{DDI\,(Q)}$					
5 V/3 V Operation			0.50	0.53	mA	
3 V/5 V Operation			0.26	0.31	mA	
Output Supply Current per Channel, Quiescent	$I_{DDO\,(Q)}$					
5 V/3 V Operation			0.11	0.14	mA	
3 V/5 V Operation			0.19	0.21	mA	
ADuM1400, Total Supply Current, Four Channels[2]						
DC to 2 Mbps						
V_{DD1} Supply Current	$I_{DD1\,(Q)}$					
5 V/3 V Operation			2.2	2.8	mA	DC to 1 MHz logic signal freq.
3 V/5 V Operation			1.2	1.9	mA	DC to 1 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2\,(Q)}$					
5 V/3 V Operation			0.5	0.9	mA	DC to 1 MHz logic signal freq.
3 V/5 V Operation			0.9	1.4	mA	DC to 1 MHz logic signal freq.
10 Mbps (BRW and CRW Grades Only)						
V_{DD1} Supply Current	$I_{DD1\,(10)}$					
5 V/3 V Operation			8.6	10.6	mA	5 MHz logic signal freq.
3 V/5 V Operation			4.5	6.5	mA	5 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2\,(10)}$					
5 V/3 V Operation			1.4	2.0	mA	5 MHz logic signal freq.
3 V/5 V Operation			2.6	3.5	mA	5 MHz logic signal freq.
90 Mbps (CRW Grade Only)						
V_{DD1} Supply Current	$I_{DD1\,(90)}$					
5 V/3 V Operation			70	100	mA	45 MHz logic signal freq.
3 V/5 V Operation			37	65	mA	45 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2\,(90)}$					
5 V/3 V Operation			11	15	mA	45 MHz logic signal freq.
3 V/5 V Operation			18	25	mA	45 MHz logic signal freq.
ADuM1401, Total Supply Current, Four Channels[2]						
DC to 2 Mbps						
V_{DD1} Supply Current	$I_{DD1\,(Q)}$					
5 V/3 V Operation			1.8	2.4	mA	DC to 1 MHz logic signal freq.
3 V/5 V Operation			1.0	1.6	mA	DC to 1 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2\,(Q)}$					
5 V/3 V Operation			0.7	1.2	mA	DC to 1 MHz logic signal freq.
3 V/5 V Operation			1.2	1.8	mA	DC to 1 MHz logic signal freq.
10 Mbps (BRW and CRW Grades Only)						
V_{DD1} Supply Current	$I_{DD1\,(10)}$					
5 V/3 V Operation			7.1	9.0	mA	5 MHz logic signal freq.
3 V/5 V Operation			3.7	5.4	mA	5 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2\,(10)}$					
5 V/3 V Operation			2.2	3.0	mA	5 MHz logic signal freq.
3 V/5 V Operation			4.1	5.0	mA	5 MHz logic signal freq.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
90 Mbps (CRW Grade Only)						
V_{DD1} Supply Current	$I_{DD1 (90)}$					
5 V/3 V Operation			57	82	mA	45 MHz logic signal freq.
3 V/5 V Operation			30	52	mA	45 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (90)}$					
5 V/3 V Operation			18	27	mA	45 MHz logic signal freq.
3 V/5 V Operation			31	43	mA	45 MHz logic signal freq.
ADuM1402, Total Supply Current, Four Channels[2]						
DC to 2 Mbps						
V_{DD1} Supply Current	$I_{DD1 (Q)}$					
5 V/3 V Operation			1.5	2.1	mA	DC to 1 MHz logic signal freq.
3 V/5 V Operation			0.9	1.5	mA	DC to 1 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (Q)}$					
5 V/3 V Operation			0.9	1.5	mA	DC to 1 MHz logic signal freq.
3 V/5 V Operation			1.5	2.1	mA	DC to 1 MHz logic signal freq.
10 Mbps (BRW and CRW Grades Only)						
V_{DD1} Supply Current	$I_{DD1 (10)}$					
5 V/3 V Operation			5.6	7.0	mA	5 MHz logic signal freq.
3 V/5 V Operation			3.0	4.2	mA	5 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (10)}$					
5 V/3 V Operation			3.0	4.2	mA	5 MHz logic signal freq.
3 V/5 V Operation			5.6	7.0	mA	5 MHz logic signal freq.
90 Mbps (CRW Grade Only)						
V_{DD1} Supply Current	$I_{DD1 (90)}$					
5 V/3 V Operation			44	62	mA	45 MHz logic signal freq.
3 V/5 V Operation			24	39	mA	45 MHz logic signal freq.
V_{DD2} Supply Current	$I_{DD2 (90)}$					
5 V/3 V Operation			24	39	mA	45 MHz logic signal freq.
3 V/5 V Operation			44	62	mA	45 MHz logic signal freq.
For All Models						
Input Currents	I_{IA}, I_{IB}, I_{IC}, I_{ID}, I_{E1}, I_{E2}	−10	+0.01	+10	µA	$0 \le V_{IA}, V_{IB}, V_{IC}, V_{ID} \le V_{DD1}$ or V_{DD2}, $0 \le V_{E1}, V_{E2} \le V_{DD1}$ or V_{DD2}
Logic High Input Threshold	V_{IH}, V_{EH}					
5 V/3 V Operation		2.0			V	
3 V/5 V Operation		1.6			V	
Logic Low Input Threshold	V_{IL}, V_{EL}					
5 V/3 V Operation				0.8	V	
3 V/5 V Operation				0.4	V	
Logic High Output Voltages	V_{OAH}, V_{OBH}, V_{OCH}, V_{ODH}	$V_{DD1}, V_{DD2} - 0.1$ $V_{DD1}, V_{DD2} - 0.4$	V_{DD1}, V_{DD2} $V_{DD1}, V_{DD2} - 0.2$		V V	$I_{Ox} = -20$ µA, $V_{Ix} = V_{IxH}$ $I_{Ox} = -4$ mA, $V_{Ix} = V_{IxH}$
Logic Low Output Voltages	V_{OAL}, V_{OBL}, V_{OCL}, V_{ODL}		0.0 0.04 0.2	0.1 0.1 0.4	V V V	$I_{Ox} = 20$ µA, $V_{Ix} = V_{IxL}$ $I_{Ox} = 400$ µA, $V_{Ix} = V_{IxL}$ $I_{Ox} = 4$ mA, $V_{Ix} = V_{IxL}$
SWITCHING SPECIFICATIONS						
ADuM140xARW						
Minimum Pulse Width[3]	PW			1000	ns	$C_L = 15$ pF, CMOS signal levels
Maximum Data Rate[4]		1			Mbps	$C_L = 15$ pF, CMOS signal levels
Propagation Delay[5]	t_{PHL}, t_{PLH}	50	70	100	ns	$C_L = 15$ pF, CMOS signal levels
Pulse Width Distortion, $\|t_{PLH} - t_{PHL}\|$[5]	PWD			40	ns	$C_L = 15$ pF, CMOS signal levels
Propagation Delay Skew[6]	t_{PSK}			50	ns	$C_L = 15$ pF, CMOS signal levels
Channel-to-Channel Matching[7]	$t_{PSKCD/OD}$			50	ns	$C_L = 15$ pF, CMOS signal levels

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
ADuM140xBRW						
Minimum Pulse Width[3]	PW			100	ns	C_L = 15 pF, CMOS signal levels
Maximum Data Rate[4]		10			Mbps	C_L = 15 pF, CMOS signal levels
Propagation Delay[5]	t_{PHL}, t_{PLH}	15	35	50	ns	C_L = 15 pF, CMOS signal levels
Pulse Width Distortion, $\|t_{PLH} - t_{PHL}\|$[5]	PWD			3	ns	C_L = 15 pF, CMOS signal levels
Change vs. Temperature			5		ps/°C	C_L = 15 pF, CMOS signal levels
Propagation Delay Skew[6]	t_{PSK}			22	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Codirectional Channels[7]	t_{PSKCD}			3	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Opposing-Directional Channels[7]	t_{PSKOD}			6	ns	C_L = 15 pF, CMOS signal levels
ADuM140xCRW						
Minimum Pulse Width[3]	PW		8.3	11.1	ns	C_L = 15 pF, CMOS signal levels
Maximum Data Rate[4]		90	120		Mbps	C_L = 15 pF, CMOS signal levels
Propagation Delay[5]	t_{PHL}, t_{PLH}	20	30	40	ns	C_L = 15 pF, CMOS signal levels
Pulse Width Distortion, $\|t_{PLH} - t_{PHL}\|$[5]	PWD		0.5	2	ns	C_L = 15 pF, CMOS signal levels
Change vs. Temperature			3		ps/°C	C_L = 15 pF, CMOS signal levels
Propagation Delay Skew[6]	t_{PSK}			14	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Codirectional Channels[7]	t_{PSKCD}			2	ns	C_L = 15 pF, CMOS signal levels
Channel-to-Channel Matching, Opposing-Directional Channels[7]	t_{PSKOD}			5	ns	C_L = 15 pF, CMOS signal levels
For All Models						
Output Disable Propagation Delay (High/Low to High Impedance)	t_{PHZ}, t_{PLH}		6	8	ns	C_L = 15 pF, CMOS signal levels
Output Enable Propagation Delay (High Impedance to High/Low)	t_{PZH}, t_{PZL}		6	8	ns	C_L = 15 pF, CMOS signal levels
Output Rise/Fall Time (10% to 90%)	t_R/t_f					C_L = 15 pF, CMOS signal levels
5 V/3 V Operation			3.0		ns	
3 V/5 V Operation			2.5		ns	
Common-Mode Transient Immunity at Logic High Output[8]	$\|CM_H\|$	25	35		kV/µs	$V_{Ix} = V_{DD1}/V_{DD2}$, V_{CM} = 1000 V, transient magnitude = 800 V
Common-Mode Transient Immunity at Logic Low Output[8]	$\|CM_L\|$	25	35		kV/µs	V_{Ix} = 0 V, V_{CM} = 1000 V, transient magnitude = 800 V
Refresh Rate	f_r					
5 V/3 V Operation			1.2		Mbps	
3 V/5 V Operation			1.1		Mbps	
Input Dynamic Supply Current per Channel[9]	$I_{DDI (D)}$					
5 V/3 V Operation			0.19		mA/Mbps	
3 V/5 V Operation			0.10		mA/Mbps	
Output Dynamic Supply Current per Channel[9]	$I_{DDI (D)}$					
5 V/3 V Operation			0.03		mA/Mbps	
3 V/5 V Operation			0.05		mA/Mbps	

[1] All voltages are relative to their respective ground.

[2] The supply current values for all four channels are combined when running at identical data rates. Output supply current values are specified with no output load present. The supply current associated with an individual channel operating at a given data rate may be calculated as described in the Power Consumption section. See Figure 8 through Figure 10 for information on per-channel supply current as a function of data rate for unloaded and loaded conditions. See Figure 11 through Figure 15 for total V_{DD1} and V_{DD2} supply currents as a function of data rate for ADuM1400/ADuM1401/ADuM1402 channel configurations.

[3] The minimum pulse width is the shortest pulse width at which the specified pulse width distortion is guaranteed.

[4] The maximum data rate is the fastest data rate at which the specified pulse width distortion is guaranteed.

[5] t_{PHL} propagation delay is measured from the 50% level of the falling edge of the V_{Ix} signal to the 50% level of the falling edge of the V_{Ox} signal. t_{PLH} propagation delay is measured from the 50% level of the rising edge of the V_{Ix} signal to the 50% level of the rising edge of the V_{Ox} signal.

[6] t_{PSK} is the magnitude of the worst-case difference in t_{PHL} or t_{PLH} that is measured between units at the same operating temperature, supply voltages, and output load within the recommended operating conditions.

[7] Codirectional channel-to-channel matching is the absolute value of the difference in propagation delays between any two channels with inputs on the same side of the isolation barrier. Opposing-directional channel-to-channel matching is the absolute value of the difference in propagation delays between any two channels with inputs on opposing sides of the isolation barrier.

[8] CM_H is the maximum common-mode voltage slew rate that can be sustained while maintaining $V_O > 0.8 \ V_{DD2}$. CM_L is the maximum common-mode voltage slew rate that can be sustained while maintaining $V_O < 0.8 \ V$. The common-mode voltage slew rates apply to both rising and falling common-mode voltage edges. The transient magnitude is the range over which the common mode is slewed.

[9] Dynamic supply current is the incremental amount of supply current required for a 1 Mbps increase in signal data rate. See Figure 8 through Figure 10 for information on per-channel supply current for unloaded and loaded conditions. See the Power Consumption section for guidance on calculating the per-channel supply current for a given data rate.

PACKAGE CHARACTERISTICS
Table 4.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Resistance (Input-to-Output)[1]	R_{I-O}		$10^{1, 2}$		Ω	
Capacitance (Input-to-Output)[1]	C_{I-O}		2.2		pF	f = 1 MHz
Input Capacitance[2]	C_I		4.0		pF	
IC Junction-to-Case Thermal Resistance, Side 1	$θ_{JCI}$		33		°C/W	Thermocouple located at center of package underside
IC Junction-to-Case Thermal Resistance, Side 2	$θ_{JCO}$		28		°C/W	

[1] Device considered a 2-terminal device; Pins 1, 2, 3, 4, 5, 6, 7, and 8 shorted together and Pins 9, 10, 11, 12, 13, 14, 15, and 16 shorted together.
[2] Input capacitance is from any input data pin to ground.

REGULATORY INFORMATION

The ADuM140x have been approved by the organizations listed in Table 5.

Table 5.

UL[1]	CSA	VDE[2]	TÜV
Recognized under 1577 component recognition program[1]	Approved under CSA Component Acceptance Notice #5A	Certified according to DIN EN 60747-5-2 (VDE 0884 Part 2): 2003-01[2]	Approved according to: IEC 61010-1:2001 (2nd Edition), EN 61010-1:2001 (2nd Edition) UL 61010-1:2004 CSA C22.2.61010.1:2005
Double/reinforced insulation, 2500 V rms isolation voltage	Reinforced insulation per CSA 60950-1-03 and IEC 60950-1, 400 V rms maximum working voltage	Basic insulation, 560 V peak	Reinforced insulation, 400 V rms maximum working voltage
		Complies with DIN EN 60747-5-2 (VDE 0884 Part 2): 2003-01, DIN EN 60950 (VDE 0805): 2001-12; EN 60950: 2000	
		Reinforced insulation, 560 V peak	
File E214100	File 205078	File 2471900-4880-0001	Certificate U8V 05 06 56232 002

[1] In accordance with UL1577, each ADuM140x is proof tested by applying an insulation test voltage ≥3000 V rms for 1 sec (current leakage detection limit = 5 μA).
[2] In accordance with DIN EN 60747-5-2, each ADuM140x is proof tested by applying an insulation test voltage ≥1050 V peak for 1 sec (partial discharge detection limit = 5 pC). The * marking branded on the component designates DIN EN 60747-5-2 approval.

INSULATION AND SAFETY-RELATED SPECIFICATIONS
Table 6.

Parameter	Symbol	Value	Unit	Conditions
Rated Dielectric Insulation Voltage		2500	V rms	1 minute duration
Minimum External Air Gap (Clearance)	L(I01)	7.7 min	mm	Measured from input terminals to output terminals, shortest distance through air
Minimum External Tracking (Creepage)	L(I02)	8.1 min	mm	Measured from input terminals to output terminals, shortest distance path along body
Minimum Internal Gap (Internal Clearance)		0.017 min	mm	Insulation distance through insulation
Tracking Resistance (Comparative Tracking Index)	CTI	>175	V	DIN IEC 112/VDE 0303 Part 1
Isolation Group		IIIa		Material Group (DIN VDE 0110, 1/89, Table 1)

DIN EN 60747-5-2 (VDE 0884 PART 2) INSULATION CHARACTERISTICS
Table 7.

Description	Symbol	Characteristic	Unit
Installation Classification per DIN VDE 0110			
For Rated Mains Voltage ≤150 V rms		I-IV	
For Rated Mains Voltage ≤300 V rms		I-III	
For Rated Mains Voltage ≤400 V rms		I-II	
Climatic Classification		40/105/21	
Pollution Degree (DIN VDE 0110, Table 1)		2	
Maximum Working Insulation Voltage	V_{IORM}	560	V peak
Input-to-Output Test Voltage, Method b1	V_{PR}	1050	V peak
$V_{IORM} \times 1.875 = V_{PR}$, 100% Production Test, t_m = 1 sec, Partial Discharge < 5 pC			
Input-to-Output Test Voltage, Method a	V_{PR}		
After Environmental Tests Subgroup 1		896	V peak
$V_{IORM} \times 1.6 = V_{PR}$, t_m = 60 sec, Partial Discharge < 5 pC			
After Input and/or Safety Test Subgroup 2/3		672	V peak
$V_{IORM} \times 1.2 = V_{PR}$, t_m = 60 sec, Partial Discharge < 5 pC			
Highest Allowable Overvoltage (Transient Overvoltage, t_{TR} = 10 sec)	V_{TR}	4000	V peak
Safety-Limiting Values (Maximum Value Allowed in the Event of a Failure; also see Figure 4)			
Case Temperature	T_S	150	°C
Side 1 Current	I_{S1}	265	mA
Side 2 Current	I_{S2}	335	mA
Insulation Resistance at T_S, V_{IO} = 500 V	R_S	>10^9	Ω

These isolators are suitable for basic electrical isolation only within the safety limit data. Maintenance of the safety data is ensured by protective circuits.

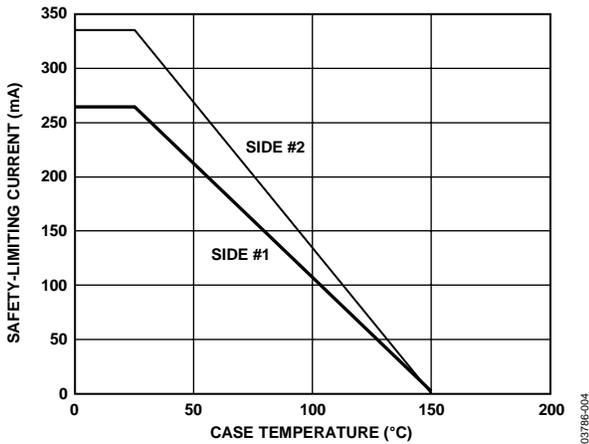The * marking on packages denotes DIN EN 60747-5-2 approval.

Figure 4. Thermal Derating Curve, Dependence of Safety-Limiting Values with Case Temperature per DIN EN 60747-5-2

RECOMMENDED OPERATING CONDITIONS
Table 8.

Parameter	Symbol	Min	Max	Unit
Operating Temperature	T_A	−40	+105	°C
Supply Voltages[1]	V_{DD1}, V_{DD2}	2.7	5.5	V
Input Signal Rise and Fall Times			1.0	ms

[1] All voltages are relative to their respective ground. See the DC Correctness and Magnetic Field Immunity section for information on immunity to external magnetic fields.

ABSOLUTE MAXIMUM RATINGS

Ambient temperature = 25°C, unless otherwise noted.

Table 9.

Parameter	Symbol	Min	Max	Unit
Storage Temperature	T_{ST}	−65	+150	°C
Ambient Operating Temperature	T_A	−40	+105	°C
Supply Voltages[1]	V_{DD1}, V_{DD2}	−0.5	+7.0	V
Input Voltage[1, 2]	V_{IA}, V_{IB}, V_{IC}, V_{ID}, V_{E1}, V_{E2}	−0.5	V_{DDI} + 0.5	V
Output Voltage[1, 2]	V_{OA}, V_{OB}, V_{OC}, V_{OD}	−0.5	V_{DDO} + 0.5	V
Average Output Current per Pin[3]				
Side 1	I_{O1}	−18	+18	mA
Side 2	I_{O2}	−22	+22	mA
Common-Mode Transients[4]		−100	+100	kV/μs

[1] All voltages are relative to their respective ground.
[2] V_{DDI} and V_{DDO} refer to the supply voltages on the input and output sides of a given channel, respectively. See the PC Board Layout section.
[3] See Figure 4 for maximum rated current values for various temperatures.
[4] Refers to common-mode transients across the insulation barrier. Common-mode transients exceeding the Absolute Maximum Ratings may cause latch-up or permanent damage.

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. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

WARNING!
ESD SENSITIVE DEVICE

Table 10. Truth Table (Positive Logic)

V_{IX} Input[1]	V_{EX} Input[2]	V_{DDI} State[1]	V_{DDO} State[1]	V_{OX} Output[1]	Notes
H	H or NC	Powered	Powered	H	
L	H or NC	Powered	Powered	L	
X	L	Powered	Powered	Z	
X	H or NC	Unpowered	Powered	H	Outputs return to the input state within 1 μs of V_{DDI} power restoration.
X	L	Unpowered	Powered	Z	
X	X	Powered	Unpowered	Indeterminate	Outputs return to the input state within 1 μs of V_{DDO} power restoration if V_{EX} state is H or NC. Outputs return to high impedance state within 8 ns of V_{DDO} power restoration if V_{EX} state is L.

[1] V_{IX} and V_{OX} refer to the input and output signals of a given channel (A, B, C, or D). V_{EX} refers to the output enable signal on the same side as the V_{OX} outputs. V_{DDI} and V_{DDO} refer to the supply voltages on the input and output sides of the given channel, respectively.
[2] In noisy environments, connecting V_{EX} to an external logic high or low is recommended.
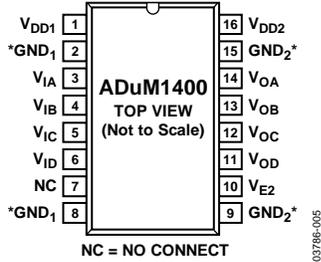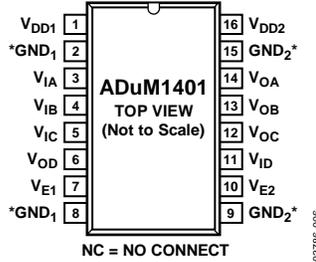
PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

V_{DD1}	1	16	V_{DD2}
*GND_1	2	15	GND_2*
V_{IA}	3	14	V_{OA}
V_{IB}	4	13	V_{OB}
V_{IC}	5	12	V_{OC}
V_{ID}	6	11	V_{OD}
NC	7	10	V_{E2}
*GND_1	8	9	GND_2*

ADuM1400 TOP VIEW (Not to Scale)
NC = NO CONNECT

Figure 5. ADuM1400 Pin Configuration

V_{DD1}	1	16	V_{DD2}
*GND_1	2	15	GND_2*
V_{IA}	3	14	V_{OA}
V_{IB}	4	13	V_{OB}
V_{IC}	5	12	V_{OC}
V_{OD}	6	11	V_{ID}
V_{E1}	7	10	V_{E2}
*GND_1	8	9	GND_2*

ADuM1401 TOP VIEW (Not to Scale)
NC = NO CONNECT

Figure 6. ADuM1401 Pin Configuration

V_{DD1}	1	16	V_{DD2}
*GND_1	2	15	GND_2*
V_{IA}	3	14	V_{OA}
V_{IB}	4	13	V_{OB}
V_{OC}	5	12	V_{IC}
V_{OD}	6	11	V_{ID}
V_{E1}	7	10	V_{E2}
*GND_1	8	9	GND_2*

ADuM1402 TOP VIEW (Not to Scale)
NC = NO CONNECT
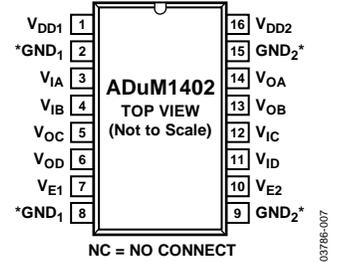
Figure 7. ADuM1402 Pin Configuration

*Pins 2 and 8 are internally connected, and connecting both to GND_1 is recommended. Pins 9 and 15 are internally connected, and connecting both to GND_2 is recommended. In noisy environments, connecting the output enables (Pin 7 for ADuM1401/ADuM1402 and Pin 10 for all models) to an external logic high or low is recommended.

Table 11. ADuM1400 Pin Function Descriptions

Pin No.	Mnemonic	Function
1	V_{DD1}	Supply Voltage for Isolator Side 1, 2.7 V to 5.5 V.
2	GND_1	Ground 1. Ground reference for isolator Side 1.
3	V_{IA}	Logic Input A.
4	V_{IB}	Logic Input B.
5	V_{IC}	Logic Input C.
6	V_{ID}	Logic Input D.
7	NC	No Connect.
8	GND_1	Ground 1. Ground reference for isolator Side 1.
9	GND_2	Ground 2. Ground reference for isolator Side 2.
10	V_{E2}	Output Enable 2. Active high logic input. V_{OA}, V_{OB}, V_{OC}, and V_{OD} outputs are enabled when V_{E2} is high or disconnected. V_{OA}, V_{OB}, V_{OC}, and V_{OD} outputs are disabled when V_{E2} is low. In noisy environments, connecting V_{E2} to an external logic high or low is recommended.
11	V_{OD}	Logic Output D.
12	V_{OC}	Logic Output C.
13	V_{OB}	Logic Output B.
14	V_{OA}	Logic Output A.
15	GND_2	Ground 2. Ground reference for isolator Side 2.
16	V_{DD2}	Supply Voltage for Isolator Side 2, 2.7 V to 5.5 V.

Table 12. ADuM1401 Pin Function Descriptions

Pin No.	Mnemonic	Function
1	V_{DD1}	Supply Voltage for Isolator Side 1, 2.7 V to 5.5 V.
2	GND_1	Ground 1. Ground reference for isolator Side 1.
3	V_{IA}	Logic Input A.
4	V_{IB}	Logic Input B.
5	V_{IC}	Logic Input C.
6	V_{OD}	Logic Output D.
7	V_{E1}	Output Enable 1. Active high logic input. V_{OD} output is enabled when V_{E1} is high or disconnected. V_{OD} is disabled when V_{E1} is low. In noisy environments, connecting V_{E1} to an external logic high or low is recommended.
8	GND_1	Ground 1. Ground reference for isolator Side 1.
9	GND_2	Ground 2. Ground reference for isolator Side 2.
10	V_{E2}	Output Enable 2. Active high logic input. V_{OA}, V_{OB}, and V_{OC} outputs are enabled when V_{E2} is high or disconnected. V_{OA}, V_{OB}, and V_{OC} outputs are disabled when V_{E2} is low. In noisy environments, connecting V_{E2} to an external logic high or low is recommended.
11	V_{ID}	Logic Input D.
12	V_{OC}	Logic Output C.
13	V_{OB}	Logic Output B.
14	V_{OA}	Logic Output A.
15	GND_2	Ground 2. Ground reference for isolator Side 2.
16	V_{DD2}	Supply Voltage for Isolator Side 1, 2.7 V to 5.5 V.

Table 13. ADuM1402 Pin Function Descriptions

| Pin No.	Mnemonic	Function
1	V_{DD1}	Supply Voltage for Isolator Side 1, 2.7 V to 5.5 V.
2	GND_1	Ground 1. Ground reference for isolator Side 1.
3	V_{IA}	Logic Input A.
4	V_{IB}	Logic Input B.
5	V_{OC}	Logic Output C.
6	V_{OD}	Logic Output D.
7	V_{E1}	Output Enable 1. Active high logic input. V_{OC} and V_{OD} outputs are enabled when V_{E1} is high or disconnected. V_{OC} and V_{OD} outputs are disabled when V_{E1} is low. In noisy environments, connecting V_{E1} to an external logic high or low is recommended.
8	GND_1	Ground 1. Ground reference for isolator Side 1.
9	GND_2	Ground 2. Ground reference for isolator Side 2.
10	V_{E2}	Output Enable 2. Active high logic input. V_{OA} and V_{OB} outputs are enabled when V_{E2} is high or disconnected. V_{OA} and V_{OB} outputs are disabled when V_{E2} is low. In noisy environments, connecting V_{E2} to an external logic high or low is recommended.
11	V_{ID}	Logic Input D.
12	V_{IC}	Logic Input C.
13	V_{OB}	Logic Output B.
14	V_{OA}	Logic Output A.
15	GND_2	Ground 2. Ground Reference for Isolator Side 2.
16	V_{DD2}	Supply Voltage for Isolator Side 2, 2.7 V to 5.5 V.

TYPICAL PERFORMANCE CHARACTERISTICS
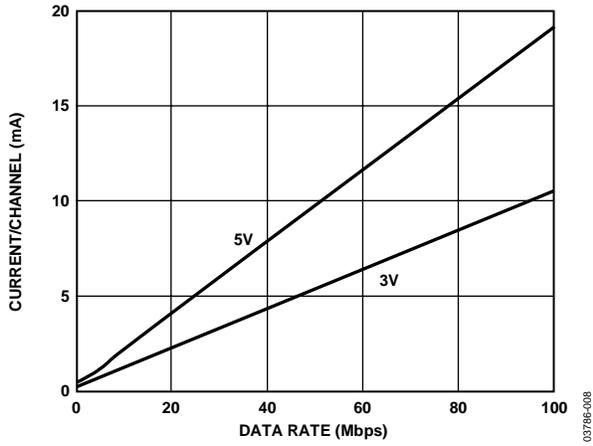
Figure 8. Typical Input Supply Current per Channel vs. Data Rate
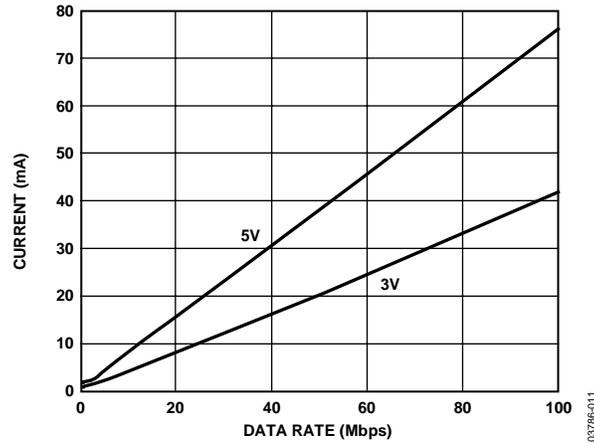for 5 V and 3 V Operation

Figure 11. Typical ADuM1400 V_{DD1} Supply Current vs. Data Rate
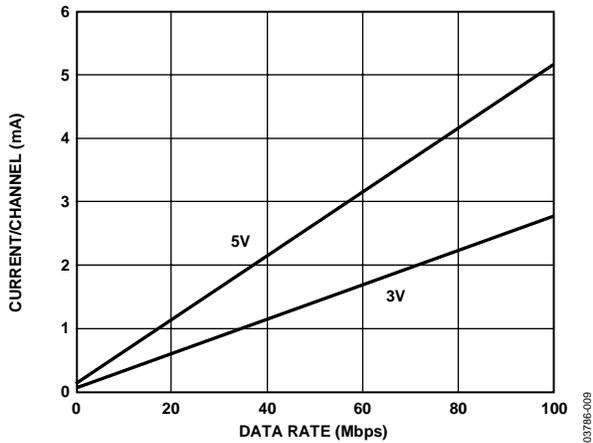for 5 V and 3 V Operation

Figure 9. Typical Output Supply Current per Channel vs. Data Rate
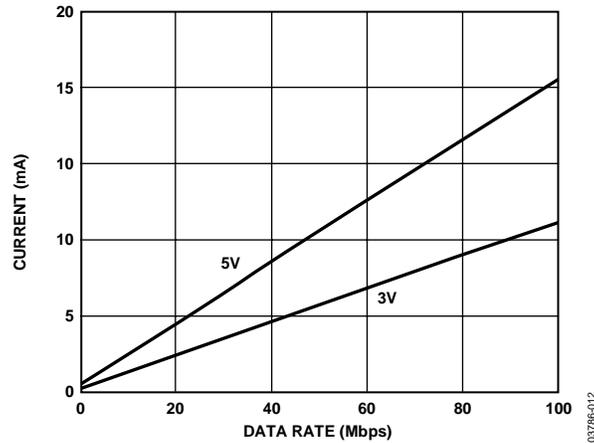for 5 V and 3 V Operation (No Output Load)

Figure 12. Typical ADuM1400 V_{DD2} Supply Current vs. Data Rate
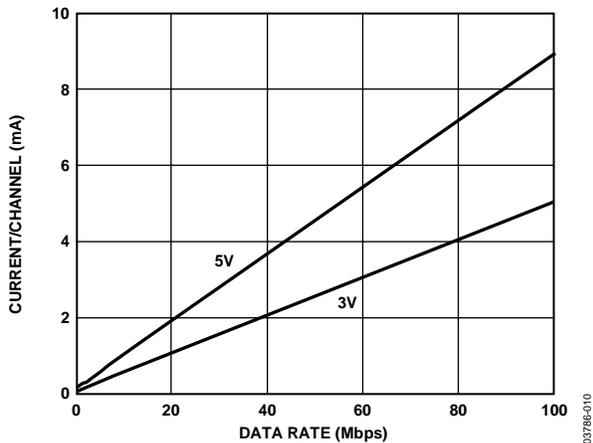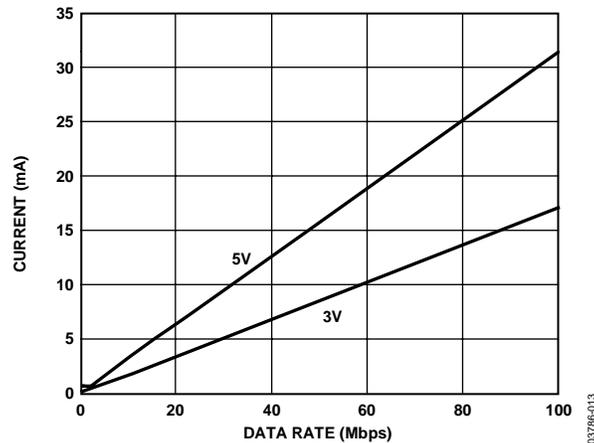for 5 V and 3 V Operation

Figure 10. Typical Output Supply Current per Channel vs. Data Rate
for 5 V and 3 V Operation (15 pF Output Load)

Figure 13. Typical ADuM1401 V_{DD1} Supply Current vs. Data Rate
for 5 V and 3 V Operation

Figure 14. Typical ADuM1401 V_{DD2} Supply Current vs. Data Rate
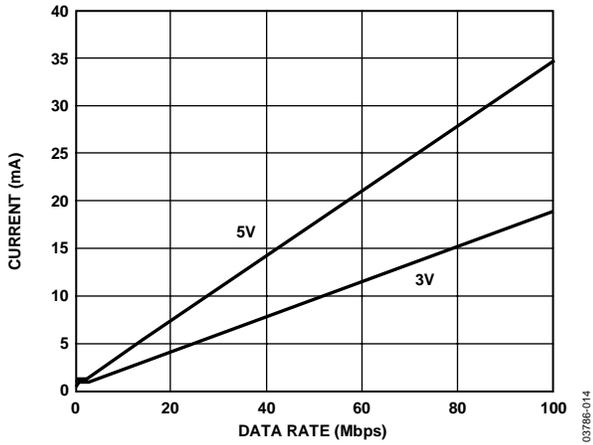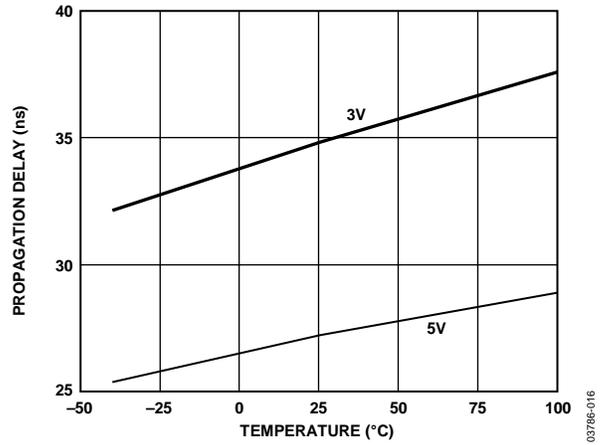for 5 V and 3 V Operation

Figure 15. Typical ADuM1402 V_{DD1} or V_{DD2} Supply Current vs.
Data Rate for 5 V and 3 V Operation

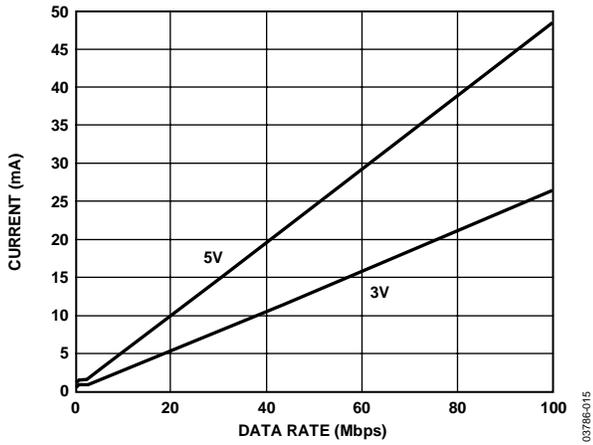Figure 16. Propagation Delay vs. Temperature, C Grade

APPLICATION INFORMATION

PC BOARD LAYOUT

The ADuM140x digital isolator requires no external interface circuitry for the logic interfaces. Power supply bypassing is strongly recommended at the input and output supply pins (Figure 17). Bypass capacitors are most conveniently connected between Pins 1 and 2 for V_{DD1} and between Pins 15 and 16 for V_{DD2}. The capacitor value should be between 0.01 μF and 0.1 μF. The total lead length between both ends of the capacitor and the input power supply pin should not exceed 20 mm. Bypassing between Pins 1 and 8 and between Pins 9 and 16 should also be considered unless the ground pair on each package side is connected close to the package.
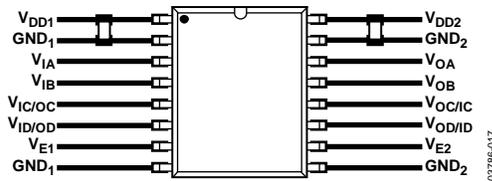

Figure 17. Recommended Printed Circuit Board Layout

In applications involving high common-mode transients, care should be taken to ensure that board coupling across the isolation barrier is minimized. Furthermore, the board layout should be designed such that any coupling that does occur equally affects all pins on a given component side. Failure to ensure this could cause voltage differentials between pins exceeding the device's Absolute Maximum Ratings, thereby leading to latch-up or permanent damage.

PROPAGATION DELAY-RELATED PARAMETERS

Propagation delay is a parameter that describes the time it takes a logic signal to propagate through a component. The propagation delay to a logic low output may differ from the propagation delay to a logic high.
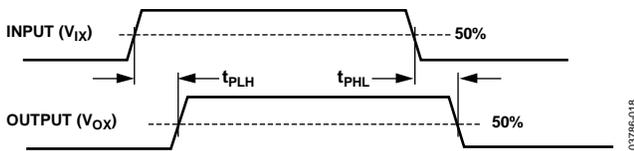

Figure 18. Propagation Delay Parameters

Pulse width distortion is the maximum difference between these two propagation delay values and is an indication of how accurately the input signal's timing is preserved.

Channel-to-channel matching refers to the maximum amount the propagation delay differs between channels within a single ADuM140x component.

Propagation delay skew refers to the maximum amount the propagation delay differs between multiple ADuM140x components operating under the same conditions.

DC CORRECTNESS AND MAGNETIC FIELD IMMUNITY

Positive and negative logic transitions at the isolator input cause narrow (~1 ns) pulses to be sent to the decoder via the transformer. The decoder is bistable and is, therefore, either set or reset by the pulses, indicating input logic transitions. In the absence of logic transitions at the input for more than 2 μs, a periodic set of refresh pulses indicative of the correct input state are sent to ensure dc correctness at the output. If the decoder receives no internal pulses of more than about 5 μs, the input side is assumed to be unpowered or nonfunctional, in which case the isolator output is forced to a default state (see Table 10) by the watchdog timer circuit.

The limitation on the ADuM140x's magnetic field immunity is set by the condition in which induced voltage in the transformer's receiving coil is sufficiently large to either falsely set or reset the decoder. The following analysis defines the conditions under which this may occur. The 3 V operating condition of the ADuM140x is examined because it represents the most susceptible mode of operation.

The pulses at the transformer output have an amplitude greater than 1.0 V. The decoder has a sensing threshold at about 0.5 V, thus establishing a 0.5 V margin in which induced voltages can be tolerated. The voltage induced across the receiving coil is given by

$$V = (-d\beta/dt)\sum \prod r_n^2; \; n = 1, 2, \ldots, N$$

where:
β is magnetic flux density (gauss).
N is the number of turns in the receiving coil.
r_n is the radius of the nth turn in the receiving coil (cm).

Given the geometry of the receiving coil in the ADuM140x and an imposed requirement that the induced voltage be at most 50% of the 0.5 V margin at the decoder, a maximum allowable magnetic field is calculated as shown in Figure 19.
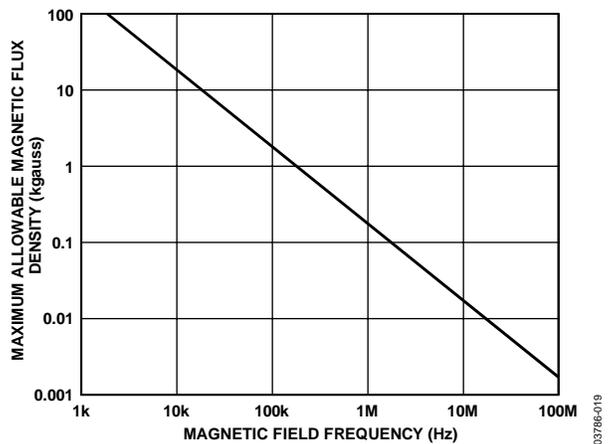

Figure 19. Maximum Allowable External Magnetic Flux Density

For example, at a magnetic field frequency of 1 MHz, the maximum allowable magnetic field of 0.2 kgauss induces a voltage of 0.25 V at the receiving coil. This is about 50% of the sensing threshold and does not cause a faulty output transition. Similarly, if such an event were to occur during a transmitted pulse (and was of the worst-case polarity), it would reduce the received pulse from >1.0 V to 0.75 V—still well above the 0.5 V sensing threshold of the decoder.

The preceding magnetic flux density values correspond to specific current magnitudes at given distances from the ADuM140x transformers. Figure 20 expresses these allowable current magnitudes as a function of frequency for selected distances. As shown, the ADuM140x is extremely immune and can be affected only by extremely large currents operated at high frequency very close to the component. For the 1 MHz example noted, one would have to place a 0.5 kA current 5 mm away from the ADuM140x to affect the component's operation.
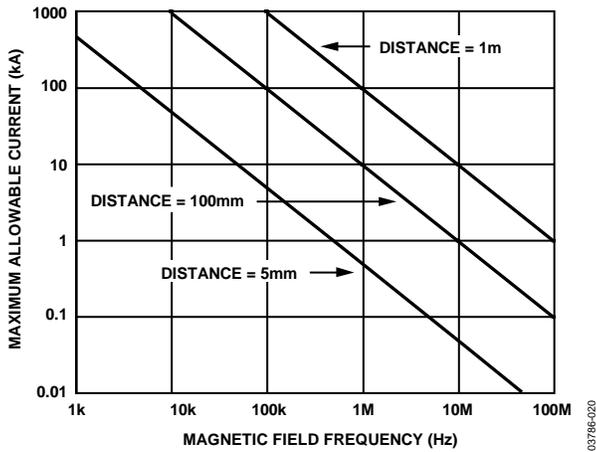

*Figure 20. Maximum Allowable Current
for Various Current-to-ADuM140x Spacings*

Note that at combinations of strong magnetic field and high frequency, any loops formed by printed circuit board traces could induce error voltages sufficiently large enough to trigger the thresholds of succeeding circuitry. Care should be taken in the layout of such traces to avoid this possibility.

POWER CONSUMPTION

The supply current at a given channel of the ADuM140x isolator is a function of the supply voltage, the channel's data rate, and the channel's output load.

For each input channel, the supply current is given by

$$I_{DDI} = I_{DDI\,(Q)} \qquad\qquad f \leq 0.5\,f_r$$

$$I_{DDI} = I_{DDI\,(D)} \times (2f - f_r) + I_{DDI\,(Q)} \qquad f > 0.5\,f_r$$

For each output channel, the supply current is given by

$$I_{DDO} = I_{DDO\,(Q)} \qquad\qquad f \leq 0.5\,f_r$$

$$I_{DDO} = (I_{DDO\,(D)} + (0.5 \times 10^{-3}) \times C_L \times V_{DDO}) \times (2f - f_r) + I_{DDO\,(Q)}$$
$$f > 0.5\,f_r$$

where:
$I_{DDI\,(D)}$, $I_{DDO\,(D)}$ are the input and output dynamic supply currents per channel (mA/Mbps).
C_L is the output load capacitance (pF).
V_{DDO} is the output supply voltage (V).
f is the input logic signal frequency (MHz); it is half of the input data rate expressed in units of Mbps.
f_r is the input stage refresh rate (Mbps).
$I_{DDI\,(Q)}$, $I_{DDO\,(Q)}$ are the specified input and output quiescent supply currents (mA).

To calculate the total V_{DD1} and V_{DD2} supply current, the supply currents for each input and output channel corresponding to V_{DD1} and V_{DD2} are calculated and totaled. Figure 8 and Figure 9 provide per-channel supply currents as a function of data rate for an unloaded output condition. Figure 10 provides per-channel supply current as a function of data rate for a 15 pF output condition. Figure 11 through Figure 15 provide total V_{DD1} and V_{DD2} supply current as a function of data rate for ADuM1400/ADuM1401/ADuM1402 channel configurations.

OUTLINE DIMENSIONS
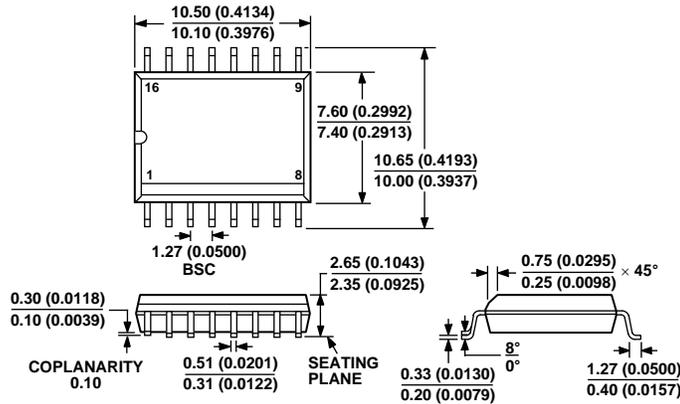
COMPLIANT TO JEDEC STANDARDS MS-013-AA
CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS
(IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR
REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 21. 16-Lead Standard Small Outline Package [SOIC_W]
Wide Body (RW-16)
Dimension shown in millimeters and (inches)

ORDERING GUIDE

Model	Number of Inputs, V_{DD1} Side	Number of Inputs, V_{DD2} Side	Maximum Data Rate (Mbps)	Maximum Propagation Delay, 5 V (ns)	Maximum Pulse Width Distortion (ns)	Temperature Range (°C)	Package Option[1]
ADuM1400ARW[2]	4	0	1	100	40	−40 to +105	RW-16
ADuM1400BRW[2]	4	0	10	50	3	−40 to +105	RW-16
ADuM1400CRW[2]	4	0	90	32	2	−40 to +105	RW-16
ADuM1400ARWZ[2, 3]	4	0	1	100	40	−40 to +105	RW-16
ADuM1400BRWZ[2, 3]	4	0	10	50	3	−40 to +105	RW-16
ADuM1400CRWZ[2, 3]	4	0	90	32	2	−40 to +105	RW-16
ADuM1401ARW[2]	3	1	1	100	40	−40 to +105	RW-16
ADuM1401BRW[2]	3	1	10	50	3	−40 to +105	RW-16
ADuM1401CRW[2]	3	1	90	32	2	−40 to +105	RW-16
ADuM1401ARWZ[2, 3]	3	1	1	100	40	−40 to +105	RW-16
ADuM1401BRWZ[2, 3]	3	1	10	50	3	−40 to +105	RW-16
ADuM1401CRWZ[2, 3]	3	1	90	32	2	−40 to +105	RW-16
ADuM1402ARW[2]	2	2	1	100	40	−40 to +105	RW-16
ADuM1402BRW[2]	2	2	10	50	3	−40 to +105	RW-16
ADuM1402CRW[2]	2	2	90	32	2	−40 to +105	RW-16
ADuM1402ARWZ[2, 3]	2	2	1	100	40	−40 to +105	RW-16
ADuM1402BRWZ[2, 3]	2	2	10	50	3	−40 to +105	RW-16
ADuM1402CRWZ[2, 3]	2	2	90	32	2	−40 to +105	RW-16
EVAL-ADuM1402EBA							Evaluation Board
EVAL-ADuM1402EBB							Evaluation Board
EVAL-ADuM1402EBC							Evaluation Board

[1] RW-16 = 16-lead wide body SOIC.
[2] Tape and reel are available. The addition of an -RL suffix designates a 13″ (1,000 units) tape-and-reel option.
[3] Z = Pb-free part.

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C03786-0-2/06(D)

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