

### FEATURES

- Bidirectional I<sup>2</sup>C communication**
- Open-drain interfaces**
- Suitable for hot swap applications**
- 30 mA current sink capability**
- 1000 kHz operation**
- 3.0 V to 5.5 V supply/logic levels**
- 8-lead SOIC RoHS-compliant package**
- High temperature operation: 125°C**
- Qualified for automotive applications**
- 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 V VDE V 0884-10 (VDE V 0884-10):2006-12
    - V<sub>IORM</sub> = 560 V peak

### APPLICATIONS

- Isolated I<sup>2</sup>C, SMBus, or PMBus interfaces**
- Multilevel I<sup>2</sup>C interfaces**
- Power supplies**
- Networking**
- Power-over-Ethernet**
- Hybrid electric vehicle battery management**

### GENERAL DESCRIPTION

The ADuM1250/ADuM1251<sup>1</sup> are hot swappable digital isolators with nonlatching, bidirectional communication channels compatible with I<sup>2</sup>C<sup>®</sup> interfaces. This eliminates the need for splitting I<sup>2</sup>C signals into separate transmit and receive signals for use with standalone optocouplers.

The ADuM1250 provides two bidirectional channels, supporting a complete isolated I<sup>2</sup>C interface. The ADuM1251 provides one bidirectional channel and one unidirectional channel for those applications where a bidirectional clock is not required.

<sup>1</sup> Protected by U.S. Patents 5,952,849; 6,873,065; and 7,075,329.

#### Rev. D

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### FUNCTIONAL BLOCK DIAGRAMS

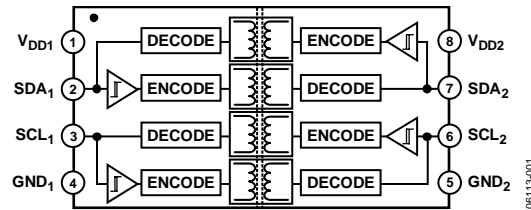


Figure 1. ADuM1250

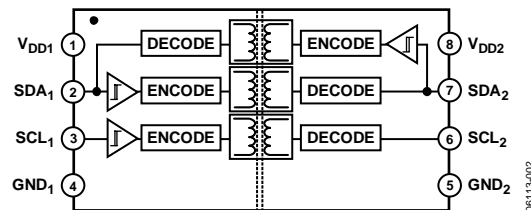


Figure 2. ADuM1251

Both the ADuM1250 and ADuM1251 contain hot swap circuitry to prevent glitching data when an unpowered card is inserted onto an active bus.

These isolators are based on *iCoupler*<sup>®</sup> chip scale transformer technology from Analog Devices, Inc. *iCoupler* is a magnetic isolation technology with functional, performance, size, and power consumption advantages as compared to optocouplers. With the ADuM1250/ADuM1251, *iCoupler* channels can be integrated with semiconductor circuitry, which enables a complete isolated I<sup>2</sup>C interface to be implemented in a small form factor.

## TABLE OF CONTENTS

Features .....	1	Absolute Maximum Ratings .....	7
Applications.....	1	ESD Caution.....	7
Functional Block Diagrams.....	1	Pin Configuration and Function Descriptions.....	8
General Description .....	1	Test Conditions.....	9
Revision History .....	2	Applications Information .....	10
Specifications.....	3	Functional Description.....	10
Electrical Characteristics .....	3	Startup.....	10
Package Characteristics .....	5	Typical Application Diagram.....	11
Regulatory Information.....	5	Magnetic Field Immunity.....	11
Insulation and Safety-Related Specifications.....	5	Outline Dimensions .....	12
DIN V VDE V 0884-10 (VDE V 0884-10) Insulation		Ordering Guide .....	12
Characteristics .....	6	Automotive Products.....	12
Recommended Operating Conditions .....	6		

## REVISION HISTORY

### 7/11—Rev. C to Rev. D

Change to Typical Application Diagram Section .....	11
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### 5/10—Rev. B to Rev. C

Changes to Features Section and Applications Section.....	1
Changed $V_{DD1} = 5\text{ V}$ , and $V_{DD2} = 5\text{ V}$ to $V_{DD1} = 3.3\text{ V}$ or $5\text{ V}$ , and $V_{DD2} = 3.3\text{ V}$ or $5\text{ V}$ .....	3
Changed $V_{DD1} = 5\text{ V}$ , and $V_{DD2} = 5\text{ V}$ to $V_{DD1} = 3.3\text{ V}$ or $5\text{ V}$ , and $V_{DD2} = 3.3\text{ V}$ or $5\text{ V}$ .....	4
Changes to Typical Application Diagram Section and Figure 9 .....	11
Changes to Ordering Guide .....	12
Added Automotive Products Section.....	12

### 12/09—Rev. A to Rev. B

Changes to Features Section.....	1
Changes to Operating Temperature ( $T_A$ ) Parameter, Table 7 .....	6
Changes to Ambient Operating Temperature ( $T_A$ ) Parameter, Table 8 .....	7
Changes to Ordering Guide .....	12

### 6/07—Rev. 0 to Rev. A

Updated VDE Certification Throughout.....	1
Changes to Features and Note 1 .....	1
Changes to Table 4 and Table 5.....	5
Changes to Table 6.....	6
Updated Outline Dimensions.....	12
Changes to Ordering Guide .....	12

### 10/06—Revision 0: Initial Version

## SPECIFICATIONS

### ELECTRICAL CHARACTERISTICS

#### DC Specifications<sup>1</sup>

All minimum/maximum specifications apply over the entire recommended operating range, unless otherwise noted. All typical specifications are at  $T_A = 25^\circ\text{C}$ ,  $V_{DD1} = 3.3\text{ V}$  or  $5\text{ V}$ , and  $V_{DD2} = 3.3\text{ V}$  or  $5\text{ V}$ , unless otherwise noted.

Table 1.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
ADuM1250						
Input Supply Current, Side 1, 5 V	$I_{DD1}$		2.8	5.0	mA	$V_{DD1} = 5\text{ V}$
Input Supply Current, Side 2, 5 V	$I_{DD2}$		2.7	5.0	mA	$V_{DD2} = 5\text{ V}$
Input Supply Current, Side 1, 3.3 V	$I_{DD1}$		1.9	3.0	mA	$V_{DD1} = 3.3\text{ V}$
Input Supply Current, Side 2, 3.3 V	$I_{DD2}$		1.7	3.0	mA	$V_{DD2} = 3.3\text{ V}$
ADuM1251						
Input Supply Current, Side 1, 5 V	$I_{DD1}$		2.8	6.0	mA	$V_{DD1} = 5\text{ V}$
Input Supply Current, Side 2, 5 V	$I_{DD2}$		2.5	4.7	mA	$V_{DD2} = 5\text{ V}$
Input Supply Current, Side 1, 3.3 V	$I_{DD1}$		1.8	3.0	mA	$V_{DD1} = 3.3\text{ V}$
Input Supply Current, Side 2, 3.3 V	$I_{DD2}$		1.6	2.8	mA	$V_{DD2} = 3.3\text{ V}$
LEAKAGE CURRENTS	$I_{SDA1}, I_{SDA2},$ $I_{SCL1}, I_{SCL2}$		0.01	10	$\mu\text{A}$	$V_{SDA1} = V_{DD1}, V_{SDA2} = V_{DD2},$ $V_{SCL1} = V_{DD1}, V_{SCL2} = V_{DD2}$
SIDE 1 LOGIC LEVELS						
Logic Input Threshold <sup>2</sup>	$V_{SDA1T}, V_{SCL1T}$	500		700	mV	
Logic Low Output Voltages	$V_{SDA1OL}, V_{SCL1OL}$	600		900	mV	$I_{SDA1} = I_{SCL1} = 3.0\text{ mA}$
		600		850	mV	$I_{SDA1} = I_{SCL1} = 0.5\text{ mA}$
Input/Output Logic Low Level Difference <sup>3</sup>	$\Delta V_{SDA1}, \Delta V_{SCL1}$	50			mV	
SIDE 2 LOGIC LEVELS						
Logic Low Input Voltage	$V_{SDA2IL}, V_{SCL2IL}$			$0.3 V_{DD2}$	V	
Logic High Input Voltage	$V_{SDA2IH}, V_{SCL2IH}$	$0.7 V_{DD2}$			V	
Logic Low Output Voltage	$V_{SDA2OL}, V_{SCL2OL}$			400	mV	$I_{SDA2} = I_{SCL2} = 30\text{ mA}$

<sup>1</sup> All voltages are relative to their respective ground.

<sup>2</sup>  $V_{IL} < 0.5\text{ V}$ ,  $V_{IH} > 0.7\text{ V}$ .

<sup>3</sup>  $\Delta V_{S1} = V_{S1OL} - V_{S1T}$ . This is the minimum difference between the output logic low level and the input logic threshold within a given component. This ensures that there is no possibility of the part latching up the bus to which it is connected.

# ADuM1250/ADuM1251

## AC Specifications<sup>1</sup>

All minimum/maximum specifications apply over the entire recommended operating range, unless otherwise noted. All typical specifications are at  $T_A = 25^\circ\text{C}$ ,  $V_{DD1} = 3.3\text{ V}$  or  $5\text{ V}$ , and  $V_{DD2} = 3.3\text{ V}$  or  $5\text{ V}$ , unless otherwise noted. Refer to Figure 5.

Table 2.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
MAXIMUM FREQUENCY		1000			kHz	
OUTPUT FALL TIME						
5 V Operation						$4.5\text{ V} \leq V_{DD1}, V_{DD2} \leq 5.5\text{ V}, C_{L1} = 40\text{ pF}, R_1 = 1.6\text{ k}\Omega, C_{L2} = 400\text{ pF}, R_2 = 180\text{ }\Omega$
Side 1 Output ( $0.9 V_{DD1}$ to $0.9\text{ V}$ )	$t_{f1}$	13	26	120	ns	
Side 2 Output ( $0.9 V_{DD2}$ to $0.1 V_{DD2}$ )	$t_{f2}$	32	52	120	ns	
3 V Operation						$3.0\text{ V} \leq V_{DD1}, V_{DD2} \leq 3.6\text{ V}, C_{L1} = 40\text{ pF}, R_1 = 1.0\text{ k}\Omega, C_{L2} = 400\text{ pF}, R_2 = 120\text{ }\Omega$
Side 1 Output ( $0.9 V_{DD1}$ to $0.9\text{ V}$ )	$t_{f1}$	13	32	120	ns	
Side 2 Output ( $0.9 V_{DD2}$ to $0.1 V_{DD2}$ )	$t_{f2}$	32	61	120	ns	
PROPAGATION DELAY						
5 V Operation						$4.5 \leq V_{DD1}, V_{DD2} \leq 5.5\text{ V}, C_{L1} = C_{L2} = 0\text{ pF}, R_1 = 1.6\text{ k}\Omega, R_2 = 180\text{ }\Omega$
Side 1-to-Side 2, Rising Edge <sup>2</sup>	$t_{PLH12}$		95	130	ns	
Side 1-to-Side 2, Falling Edge <sup>3</sup>	$t_{PHL12}$		162	275	ns	
Side 2-to-Side 1, Rising Edge <sup>4</sup>	$t_{PLH21}$		31	70	ns	
Side 2-to-Side 1, Falling Edge <sup>5</sup>	$t_{PHL21}$		85	155	ns	
3 V Operation						$3.0\text{ V} \leq V_{DD1}, V_{DD2} \leq 3.6\text{ V}, C_{L1} = C_{L2} = 0\text{ pF}, R_1 = 1.0\text{ k}\Omega, R_2 = 120\text{ }\Omega$
Side 1-to-Side 2, Rising Edge <sup>2</sup>	$t_{PLH12}$		82	125	ns	
Side 1-to-Side 2, Falling Edge <sup>3</sup>	$t_{PHL12}$		196	340	ns	
Side 2-to-Side 1, Rising Edge <sup>4</sup>	$t_{PLH21}$		32	75	ns	
Side 2-to-Side 1, Falling Edge <sup>5</sup>	$t_{PHL21}$		110	210	ns	
PULSE WIDTH DISTORTION						
5 V Operation						$4.5\text{ V} \leq V_{DD1}, V_{DD2} \leq 5.5\text{ V}, C_{L1} = C_{L2} = 0\text{ pF}, R_1 = 1.6\text{ k}\Omega, R_2 = 180\text{ }\Omega$
Side 1-to-Side 2, $ t_{PLH12} - t_{PHL12} $	$PWD_{12}$		67	145	ns	
Side 2-to-Side 1, $ t_{PLH21} - t_{PHL21} $	$PWD_{21}$		54	85	ns	
3 V Operation						$3.0\text{ V} \leq V_{DD1}, V_{DD2} \leq 3.6\text{ V}, C_{L1} = C_{L2} = 0\text{ pF}, R_1 = 1.0\text{ k}\Omega, R_2 = 120\text{ }\Omega$
Side 1-to-Side 2, $ t_{PLH12} - t_{PHL12} $	$PWD_{12}$		114	215	ns	
Side 2-to-Side 1, $ t_{PLH21} - t_{PHL21} $	$PWD_{21}$		77	135	ns	
COMMON-MODE TRANSIENT IMMUNITY <sup>6</sup>	$ CM_H ,  CM_L $	25	35		kV/ $\mu\text{s}$	

<sup>1</sup> All voltages are relative to their respective ground.

<sup>2</sup>  $t_{PLH12}$  propagation delay is measured from the Side 1 input logic threshold to an output value of  $0.7 V_{DD2}$ .

<sup>3</sup>  $t_{PHL12}$  propagation delay is measured from the Side 1 input logic threshold to an output value of  $0.4\text{ V}$ .

<sup>4</sup>  $t_{PLH21}$  propagation delay is measured from the Side 2 input logic threshold to an output value of  $0.7 V_{DD1}$ .

<sup>5</sup>  $t_{PHL21}$  propagation delay is measured from the Side 2 input logic threshold to an output value of  $0.9\text{ V}$ .

<sup>6</sup>  $CM_H$  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  $V_O < 0.8\text{ V}$ . 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.

**PACKAGE CHARACTERISTICS**

Table 3.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Resistance (Input to Output) <sup>1</sup>	R <sub>I-O</sub>		10 <sup>12</sup>		Ω	f = 1 MHz
Capacitance (Input to Output) <sup>1</sup>	C <sub>I-O</sub>		1.0		pF	
Input Capacitance	C <sub>I</sub>		4.0		pF	Thermocouple located at center of package underside
IC Junction-to-Case Thermal Resistance, Side 1	θ <sub>JCI</sub>		46		°C/W	
IC Junction-to-Case Thermal Resistance, Side 2	θ <sub>JCO</sub>		41		°C/W	

<sup>1</sup> The device is considered a 2-terminal device; Pin 1 through Pin 4 are shorted together, and Pin 5 through Pin 8 are shorted together.

**REGULATORY INFORMATION**

The ADuM1250/ADuM1251 have been approved by the organizations listed in Table 4.

Table 4.

UL	CSA	VDE
Recognized under 1577 Component Recognition Program <sup>1</sup>	Approved under CSA Component Acceptance Notice #5A	Certified according to DIN V VDE V 0884-10 (VDE V 0884-10):2006-12 <sup>2</sup>
Single/basic 2500 V rms isolation voltage	Reinforced insulation per CSA 60950-1-03 and IEC 60950-1, 125 V rms (177 V peak) maximum working voltage Basic insulation per CSA 60950-1-03 and IEC 60950-1, 400 V rms (566 V peak) maximum working voltage	Reinforced insulation, 560 V peak
File E214100	File 205078	File 2471900-4880-0001

<sup>1</sup> In accordance with UL 1577, each ADuM125x is proof tested by applying an insulation test voltage ≥3000 V rms for 1 second (current leakage detection limit = 5 μA).  
<sup>2</sup> In accordance with DIN V VDE V 0884-10, each ADuM125x is proof tested by applying an insulation test voltage ≥1050V peak for 1 second (partial discharge detection limit = 5 pC). The \* marking branded on the component designates DIN V VDE V 0884-10 approval.

**INSULATION AND SAFETY-RELATED SPECIFICATIONS**

Table 5.

Parameter	Symbol	Value	Unit	Conditions
Rated Dielectric Insulation Voltage		2500	V rms	1-minute duration
Minimum External Air Gap (Clearance)	L(I01)	4.90 min	mm	Measured from input terminals to output terminals, shortest distance through air
Minimum External Tracking (Creepage)	L(I02)	4.01 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)
Maximum Working Voltage Compatible with 50 Years Service Life	V <sub>IORM</sub>	565	V peak	Continuous peak voltage across the isolation barrier

# ADuM1250/ADuM1251

## DIN V VDE V 0884-10 (VDE V 0884-10) INSULATION CHARACTERISTICS

This isolator is suitable for reinforced isolation only within the safety limit data. Maintenance of the safety data is ensured by protective circuits. The \* marking on the package denotes DIN V VDE V 0884-10 approval for a 560 V peak working voltage.

**Table 6.**

Description	Conditions	Symbol	Characteristic	Unit
Installation Classification per DIN VDE 0110 For Rated Mains Voltage ≤ 150 V rms For Rated Mains Voltage ≤ 300 V rms For Rated Mains Voltage ≤ 400 V rms			I to IV I to III I to II	
Climatic Classification			40/105/21	
Pollution Degree per DIN VDE 0110, Table 1			2	
Maximum Working Insulation Voltage		$V_{IORM}$	560	V peak
Input-to-Output Test Voltage, Method B1	$V_{IORM} \times 1.875 = V_{PR}$ , 100% production test, $t_m = 1$ sec, partial discharge < 5 pC	$V_{PR}$	1050	V peak
Input-to-Output Test Voltage, Method A After Environmental Tests Subgroup 1 After Input and/or Safety Test Subgroup 2 and Subgroup 3	$V_{IORM} \times 1.6 = V_{PR}$ , $t_m = 60$ sec, partial discharge < 5 pC  $V_{IORM} \times 1.2 = V_{PR}$ , $t_m = 60$ sec, partial discharge < 5 pC	$V_{PR}$	896 672	V peak V peak
Highest Allowable Overvoltage	Transient overvoltage, $t_{TR} = 10$ seconds	$V_{TR}$	4000	V peak
Safety-Limiting Values	Maximum value allowed in the event of a failure (see Figure 3)			
Case Temperature		$T_S$	150	°C
$V_{DD1} + V_{DD2}$ Current		$I_{TMAX}$	212	mA
Insulation Resistance at $T_S$	$V_{IO} = 500$ V	$R_S$	>10 <sup>9</sup>	Ω

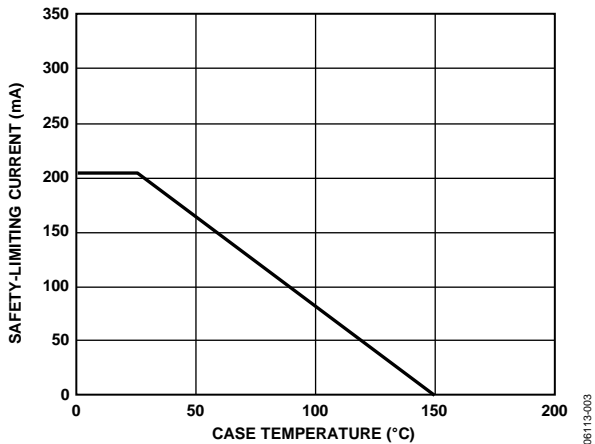


Figure 3. Thermal Derating Curve, Dependence of Safety-Limiting Values on Case Temperature, per DIN V VDE V 0884-10

## RECOMMENDED OPERATING CONDITIONS

**Table 7.**

Parameter	Rating
Operating Temperature ( $T_A$ )	
A Grade	−40°C to +105°C
S Grade	−40°C to +125°C
Supply Voltages ( $V_{DD1}$ , $V_{DD2}$ ) <sup>1</sup>	3.0 V to 5.5 V
Input/Output Signal Voltage ( $V_{SDA1}$ , $V_{SCL1}$ , $V_{SDA2}$ , $V_{SCL2}$ )	5.5 V
Capacitive Load	
Side 1 ( $C_{L1}$ )	40 pF
Side 2 ( $C_{L2}$ )	400 pF
Static Output Loading	
Side 1 ( $I_{SDA1}$ , $I_{SCL1}$ )	0.5 mA to 3 mA
Side 2 ( $I_{SDA2}$ , $I_{SCL2}$ )	0.5 mA to 30 mA

<sup>1</sup> All voltages are relative to their respective ground. See the Applications Information section for data on immunity to external magnetic fields.

## ABSOLUTE MAXIMUM RATINGS

Ambient temperature = 25°C, unless otherwise noted.

Table 8.

Parameter	Rating
Storage Temperature ( $T_{ST}$ )	-55°C to +150°C
Ambient Operating Temperature ( $T_A$ )	
A Grade	-40°C to +105°C
S Grade	-40°C to +125°C
Supply Voltages ( $V_{DD1}, V_{DD2}$ ) <sup>1</sup>	-0.5 V to +7.0 V
Input/Output Voltage,	
Side 1 ( $V_{SDA1}, V_{SCL1}$ ) <sup>1</sup>	-0.5 V to $V_{DD1} + 0.5$ V
Side 2 ( $V_{SDA2}, V_{SCL2}$ ) <sup>1</sup>	-0.5 V to $V_{DD2} + 0.5$ V
Average Output Current per Pin <sup>2</sup>	
Side 1 ( $I_{O1}$ )	±18 mA
Side 2 ( $I_{O2}$ )	±100 mA
Common-Mode Transients <sup>3</sup>	-100 kV/μs to +100 kV/μs

<sup>1</sup> All voltages are relative to their respective ground.

<sup>2</sup> See Figure 3 for maximum rated current values for various temperatures.

<sup>3</sup> Refers to common-mode transients across the insulation barrier. Common-mode transients exceeding the absolute maximum rating 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.** 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.

# ADuM1250/ADuM1251

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

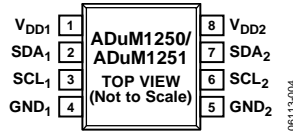


Figure 4. ADuM1250/ADuM1251 Pin Configuration

Table 9. ADuM1250 Pin Function Descriptions

Pin No.	Mnemonic	Description
1	V <sub>DD1</sub>	Supply Voltage, 3.0 V to 5.5 V.
2	SDA <sub>1</sub>	Data Input/Output, Side 1.
3	SCL <sub>1</sub>	Clock Input/Output, Side 1.
4	GND <sub>1</sub>	Ground 1. Ground reference for Isolator Side 1.
5	GND <sub>2</sub>	Ground 2. Isolated ground reference for Isolator Side 2.
6	SCL <sub>2</sub>	Clock Input/Output, Side 2.
7	SDA <sub>2</sub>	Data Input/Output, Side 2.
8	V <sub>DD2</sub>	Supply Voltage, 3.0 V to 5.5 V.

Table 10. ADuM1251 Pin Function Descriptions

Pin No.	Mnemonic	Description
1	V <sub>DD1</sub>	Supply Voltage, 3.0 V to 5.5 V.
2	SDA <sub>1</sub>	Data Input/Output, Side 1.
3	SCL <sub>1</sub>	Clock Input, Side 1.
4	GND <sub>1</sub>	Ground 1. Ground reference for Isolator Side 1.
5	GND <sub>2</sub>	Ground 2. Isolated ground reference for Isolator Side 2.
6	SCL <sub>2</sub>	Clock Output, Side 2.
7	SDA <sub>2</sub>	Data Input/Output, Side 2.
8	V <sub>DD2</sub>	Supply Voltage, 3.0 V to 5.5 V.



# TEST CONDITIONS

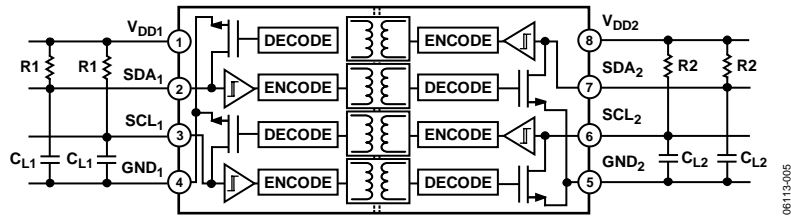


Figure 5. Timing Test Diagram

## APPLICATIONS INFORMATION

### FUNCTIONAL DESCRIPTION

The ADuM1250/ADuM1251 interfaces on each side to a bidirectional I<sup>2</sup>C signal. Internally, the I<sup>2</sup>C interface is split into two unidirectional channels communicating in opposing directions via a dedicated iCoupler isolation channel for each. One channel (the bottom channel of each channel pair shown in Figure 6) senses the voltage state of the Side 1 I<sup>2</sup>C pin and transmits its state to its respective Side 2 I<sup>2</sup>C pin.

Both the Side 1 and the Side 2 I<sup>2</sup>C pins are designed to interface to an I<sup>2</sup>C bus operating in the 3.0 V to 5.5 V range. A logic low on either causes the opposite pin to be pulled low enough to comply with the logic low threshold requirements of other I<sup>2</sup>C devices on the bus. Avoidance of I<sup>2</sup>C bus contention is ensured by an input low threshold at SDA<sub>1</sub> or SCL<sub>1</sub> guaranteed to be at least 50 mV less than the output low signal at the same pin. This prevents an output logic low at Side 1 being transmitted back to Side 2 and pulling down the I<sup>2</sup>C bus.

Since the Side 2 logic levels/thresholds are standard I<sup>2</sup>C values, multiple ADuM1250/ADuM1251 devices connected to a bus by their Side 2 pins can communicate with each other and with other devices having I<sup>2</sup>C compatibility. A distinction is made between I<sup>2</sup>C compatibility and I<sup>2</sup>C compliance. I<sup>2</sup>C compatibility refers to situations in which a component's logic levels do not necessarily meet the requirements of the I<sup>2</sup>C specification but still allow the component to communication with an I<sup>2</sup>C-compliant device. I<sup>2</sup>C compliance refers to situations in which a component's logic levels meet the requirements of the I<sup>2</sup>C specification.

However, since the Side 1 pin has a modified output level/input threshold, this side of the ADuM1250/ADuM1251 can only communicate with devices conforming to the I<sup>2</sup>C standard. In other words, Side 2 of the ADuM1250/ADuM1251 is I<sup>2</sup>C-compliant, while Side 1 is only I<sup>2</sup>C-compatible.

The output logic low levels are independent of the V<sub>DD1</sub> and V<sub>DD2</sub> voltages. The input logic low threshold at Side 1 is also independent of V<sub>DD1</sub>. However, the input logic low threshold at Side 2 is designed to be at 0.3 V<sub>DD2</sub>, consistent with I<sup>2</sup>C requirements. The Side 1 and Side 2 pins have open-collector outputs whose high levels are set via pull-up resistors to their respective supply voltages.

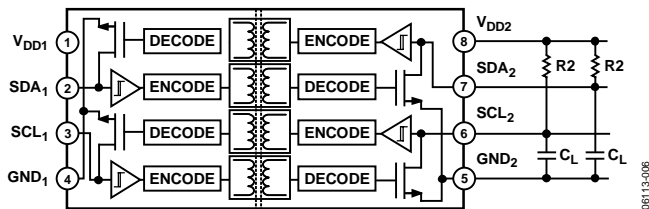


Figure 6. ADuM1250 Block Diagram

### STARTUP

Both the V<sub>DD1</sub> and V<sub>DD2</sub> supplies have an undervoltage lockout feature to prevent the signal channels from operating unless certain criteria are met. This avoids the possibility of input logic low signals from pulling down the I<sup>2</sup>C bus inadvertently during power-up/power-down.

The two criteria that must be met in order for the signal channels to be enabled are as follows:

- Both supplies must be at least 2.5 V.
- At least 40 μs must elapse after both supplies exceed the internal startup threshold of 2.0 V.

Until both of these criteria are met for both supplies, the ADuM1250/ADuM1251 outputs are pulled high, ensuring a startup that avoids any disturbances on the bus. Figure 7 and Figure 8 illustrate the supply conditions for fast and slow input supply slew rates.

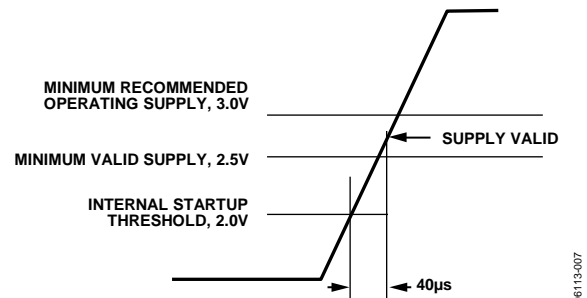


Figure 7. Start-Up Condition, Supply Slew Rate > 12.5 V/ms

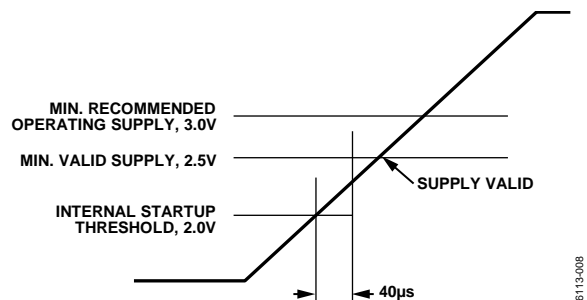


Figure 8. Start-Up Condition, Supply Slew Rate < 12.5 V/ms

## TYPICAL APPLICATION DIAGRAM

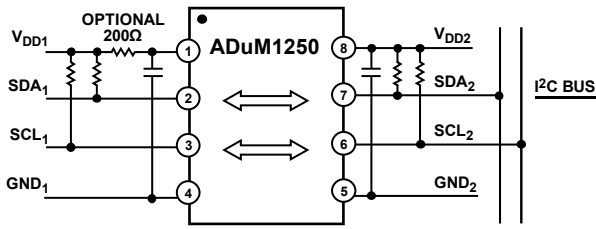


Figure 9. Typical Isolated I<sup>2</sup>C Interface Using ADuM1250

Figure 9 shows a typical application circuit including the pull-up resistors required for both Side 1 and Side 2 busses. Bypass capacitors of between 0.1 μF and 0.01 μF are required between V<sub>DD1</sub> to GND<sub>1</sub> and V<sub>DD2</sub> to GND<sub>2</sub>. The 200 Ω resistor shown in Figure 9 is required for latch-up immunity if the ambient temperature can be between 105°C and 125°C.

## MAGNETIC FIELD IMMUNITY

The ADuM125x is extremely immune to external magnetic fields. The limitation on the ADuM125x 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 ADuM125x 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

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

where:

$\beta$  is the magnetic flux density (gauss).

$N$  is the number of turns in the receiving coil.

$r_n$  is the radius of the  $n$ th turn in the receiving coil (cm).

Given the geometry of the receiving coil in the ADuM1250 and an imposed requirement that the induced voltage is at most 50% of the 0.5 V margin at the decoder, a maximum allowable magnetic field is calculated, as shown in Figure 10.

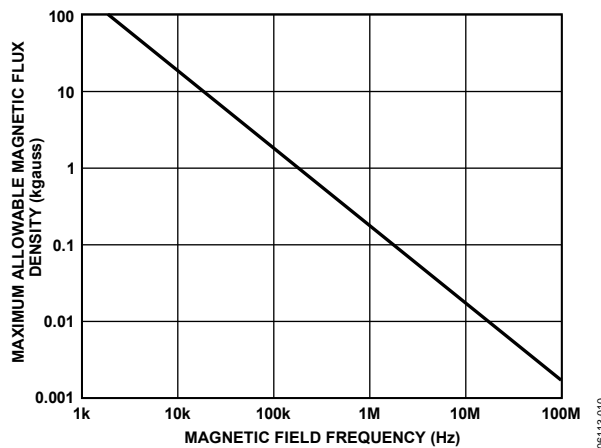


Figure 10. Maximum Allowable External Magnetic Flux Density

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 occurs during a transmitted pulse (with the worst-case polarity), it reduces the received pulse from >1.0 V to 0.75 V. Note that this is 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 away from the ADuM125x transformers. Figure 11 expresses these allowable current magnitudes as a function of frequency for selected distances. As shown in Figure 11, the ADuM125x is extremely immune and can be affected only by extremely large currents operated at high frequency and very close to the component. For the 1 MHz example, one would have to place a 0.5 kA current 5 mm away from the ADuM125x to affect the component's operation.

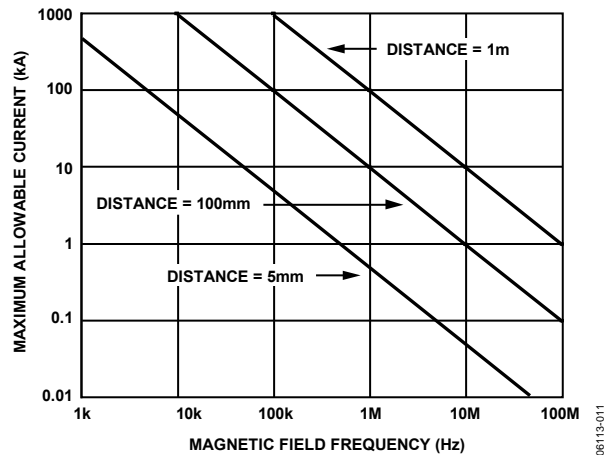
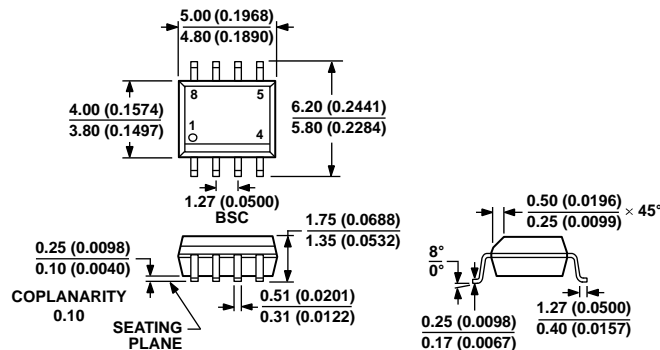


Figure 11. Maximum Allowable Current for Various Current-to-ADuM125x Spacings

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

## OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MS-012-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.

012407A

Figure 12. 8-Lead Standard Small Outline Package [SOIC\_N]  
Narrow Body  
(R-8)

Dimensions shown in millimeters (inches)

## ORDERING GUIDE

Model <sup>1, 2</sup>	Number of Inputs, V <sub>DD1</sub> Side	Number of Inputs, V <sub>DD2</sub> Side	Maximum Data Rate (Mbps)	Maximum Propagation Delay (ns)	Temperature Range	Package Description	Package Option
ADuM1250ARZ	2	2	1	150	-40°C to +105°C	8-Lead SOIC_N	R-8
ADuM1250ARZ-RL7	2	2	1	150	-40°C to +105°C	8-Lead SOIC_N	R-8
ADuM1250SRZ	2	2	1	150	-40°C to +125°C	8-Lead SOIC_N	R-8
ADuM1250 SRZ-RL7	2	2	1	150	-40°C to +125°C	8-Lead SOIC_N	R-8
ADuM1250WSRZ	2	2	1	150	-40°C to +125°C	8-Lead SOIC_N	R-8
ADuM1250 WSRZ-RL7	2	2	1	150	-40°C to +125°C	8-Lead SOIC_N	R-8
ADuM1251ARZ	2	1	1	150	-40°C to +105°C	8-Lead SOIC_N	R-8
ADuM1251ARZ-RL7	2	1	1	150	-40°C to +105°C	8-Lead SOIC_N	R-8

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

<sup>2</sup> W = Qualified for Automotive Applications.

## AUTOMOTIVE PRODUCTS

The ADuM1250W models are available with controlled manufacturing to support the quality and reliability requirements of automotive applications. Note that these automotive models may have specifications that differ from the commercial models; therefore, designers should review the Specifications section of this data sheet carefully. Only the automotive grade products shown are available for use in automotive applications. Contact your local Analog Devices account representative for specific product ordering information and to obtain the specific Automotive Reliability reports for these models.

I<sup>2</sup>C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).