General Description

The ISO1640BDR devices are low-power bidirectional isolators compatible with the I²C interface. These devices have logic input and output buffers that are separated by using a silicon dioxide (SiO_2) barrier. These devices block high voltages and prevent noise currents from entering the control side ground, avoiding circuit interference, and damaging sensitive components.

The ISO1640BDR device is based on **iDivider®** technology with functional, performance, size, and power consumption advantages as compared to optocouplers.

The ISO1640BDRprovide two bidirectional channels, supporting a complete isolated I^2C interface. The ISO1640BDR is used in applications that have a single master. This device feature independent 3.0V supplies on each side of the isolator. These devices operate from DC to 2MHzat ambient temperatures of -40°C to +125°C

Features

Bidirectional I²C communication
Ultra-low power consumption
Supports up to 2MHz operation
Open-drain interfaces
  Side 1 outputs with 3.5mA sink current
  Side 2 outputs with 35mA sink current
3.0V to 5.5V supply/logic levels
High common-mode transient immunity: 120kV/μs
typical RoHS-compliant, SOP-8

Applications

Isolated I²C, SMBus, PMBus
interfaces Multilevel I²C interfaces
Electric and Hybrid-Electric
Vehicles Open-Drain Networks
I²C Level Shifting
Power supplies

Ordering Guide

Table 1. Ordering guide

Model Name [1]	Temperature Range	Total signal channel amount	No. of Bi-directional channels	Isolation Rating (kV rms)	Package	MSL Peak Temp [2]	Quantity per reel
ISO1640BDR	–40 ~125°C	2	2	3	SOP-8	Level-2-260C-1 YEAR	4000

1. Pai2xxxxx is equals to π2xxxxx in the customer BOM. Devices with Q suffix are AEC-Q100 qualified.
2. MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Functional Block Diagrams

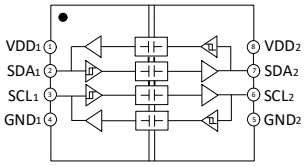
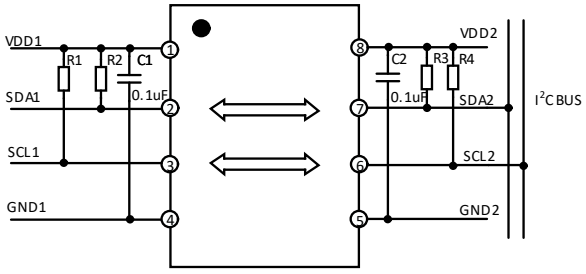


Figure 1. Functional Block Diagram



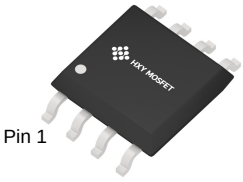


Figure 2. Typical Application Circuit

Pin Configrations And Functions

Table 2. Pin Function Descriptions

Pin No.	Name	Description
1	V_{DD1}	Supply Voltage for Isolator Side 1.
2	SDA_1	Serial data input / output, side 1.
3	SCL_1	Serial clock input / output, side 1.
4	GND_1	Ground 1. This pin is the ground reference for Isolator Side 1.
5	GND_2	Ground 2. This pin is the ground reference for Isolator Side 2.
6	SCL_2	Serial clock input / output, side 2.
7	SDA_2	Serial data input / output, side 2.
8	V_{DD2}	Supply Voltage for Isolator Side 2.

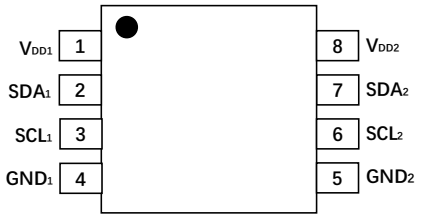


Figure 3. P in Configuration

Absolute Maximum Ratings

T_A = 25°C, unless otherwise noted.

Table 3.Absolute Maximum Ratings[4]

Parameter	Rating
Supply Voltages (V_{DD1}-GND_1, V_{DD2}-GND_2)	−0.5 V to +7.0 V
Signal Voltage SDA1/SCL1	−0.5 V to V_{DDx} + 0.5 V
Signal Voltage SDA2/SCL2	−0.5 V to V_{DDx} + 0.5 V
Average Output Current SDA1/SCL1 (I_{O1})	−20 mA to +20 mA
Average Output Current SDA2/SCL2 (I_{O2})	−100 mA to +100 mA
Storage Temperature (T_{ST}) Range	−65°C to +150°C
Maximum junction temperature $T_{J(MAX)}$	+150°C

Notes:

1. All voltage values here within are with respect to the local ground pin (GND1 or GND2) and are peak voltage values.
2. Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are 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. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

Recommended Operating Conditions

Table 4. Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{DDx} [1]	3		5.5	V
Input/Output Signal Voltage (V_{SDA1}, V_{SCL1}, V_{SDA2}, V_{SCL2})		0		V_{DDx}[1]	V
Low-level input voltage, side 1	V_{IL1}	0		0.47	V
High-level input voltage, side 1	V_{IH1}	0.7*V_{DD1}		V_{DD1}	V
Low-level input voltage, side 2	V_{IL2}	0		0.3*V_{DD2}	V
High-level input voltage, side 2	V_{IH2}	0.7*V_{DD2}		V_{DD2}	V
Output current, side 1	I_{OL1}	0.5		3.5	mA
Output current, side 2	I_{OL2}	0.5		35	mA
Capacitive load, side 1	C1			40	pF
Capacitive load, side 2	C2			400	pF
Operating frequency	f_{MAX}			2	MHz
Ambient Operating Temperature	T_A	-40		125	°C

Notes:

[1] V_{DDx} is the side voltage power supply V_{DD}, where x = 1 or 2.

Truth Tables

Table 5. Truth Table

V_{Ix} Input[1]	V_{DDI} State[1]	V_{DDO} State[1]	V_{Ox} Output[1]
Low	Powered[2]	Powered[2]	Low
High	Powered[2]	Powered[2]	High Impedance
Open[4]	Powered[2]	Powered[2]	High Impedance
Don't Care	Unpowered[3]	Powered[2]	High Impedance
Don't Care	Powered[2]	Unpowered[3]	High Impedance

Notes:

[1] V_{Ix}/V_{Ox} are the input/output signals of a given channel (SDA or SCL). V_{DDI}/V_{DDO} are the supply voltages on the input/output signal sides of this given channel. [2] Powered means $V_{DDx} \geq 2.95V$

[3] Unpowered means $V_{DDx} < 2.30V$

[4] Invalid input condition as an I²C system requires that a pullup resistor to V_{DD} is connected.

Specifications

Electrical Characteristics

Table 6. DC Specifications

V_{DD1} - V_{GND1} = V_{DD2} - V_{GND2} =3.0V ~ 5.5V, typical value is measured at T_A=25°C, unless otherwise noted.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
Side 1 Logic Levels						
Voltage input threshold low, SDA_1 and SCL_1	V_{ILT1}	470	510	570	mV	
Voltage input threshold high, SDA_1 and SCL_1	V_{IHT1}	540	580	630	mV	
Voltage input hysteresis	V_{HYST1}	30	70		mV	$V_{IHT1} - V_{ILT1}$
Low-level output voltage, SDA1 and SCL1	V_{OL1}	650	720	800	mV	0.5 mA ≤ (I_{SDA1} and I_{SCL1}) ≤ 3.5 mA
Low-level output voltage to high-level input voltage threshold difference, SDA1 and SCL1	ΔV_{OIT1}[1]	60	120		mV	0.5 mA ≤ (I_{SDA1} and I_{SCL1}) ≤ 3.5 mA
Side 2 Logic Levels						
Voltage input threshold low, SDA2 and SCL2	V_{ILT2}	0.30* V_{DD2}		0.42*V_{DD2}	V	
Voltage input threshold high, SDA2 and SCL2	V_{IHT2}	0.58* V_{DD2}		0.69*V_{DD2}	V	
Voltage input hysteresis	V_{HYST2}	0.15* V_{DD2}	0.28* V_{DD2}		V	$V_{IHT2} - V_{ILT2}$
Low-level output voltage, SDA2 and SCL2	V_{OL2}			0.4	V	0.5 mA ≤ (I_{SDA2} and I_{SCL2}) ≤ 35 mA
Both Sides						
Input leakage currents, SDA1, SCL1, SDA2, and SCL2	$\|I_{IN}\|$		0.01	10	µA	V_{SDA1}, V_{SCL1} = V_{DD1}; V_{SDA2}, V_{SCL2} = V_{DD2}
V_{DDx}[3]Undervoltage Rising Threshold	V_{DDxUV+}	2.45	2.75	2.95	V	
V_{DDx}[3]Undervoltage Falling Threshold	V_{DDxUV-}	2.30	2.60	2.80	V	
V_{DDx}[3]Hysteresis	V_{DDxUVH}		0.15		V	

Notes:

1. $\Delta V_{OIT1} = V_{OL1} - V_{IHT1}$. 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.
2. V_{DDx} is the side voltage power supply VDD, where x = 1 or 2.

Table 7. Quiescent Supply Current

V_{DD1} - V_{GND1} = V_{DD2} - V_{GND2} =3.0V ~ 5.5V, typical value is measured at T_A=25°C, unless otherwise noted.

Part	Symbol	Min	Typ	Max	Unit	Test Conditions	
						Supply voltage	Input signal
ISO1640BDR	$I_{DD1 (Q)}$		1.7	2.4	mA	$5V_{DC}$	All IO = $0V_{DC}$
	$I_{DD2 (Q)}$		1.4	2.1	mA		
	$I_{DD1 (Q)}$		1.5	2.3	mA		All IO = $5V_{DC}$
	$I_{DD2 (Q)}$		1.2	1.8	mA		
	$I_{DD1 (Q)}$		1.5	2.3	mA	$3.3V_{DC}$	All IO = $0V_{DC}$
	$I_{DD2 (Q)}$		1.2	1.8	mA		
	$I_{DD1 (Q)}$		1.5	2.3	mA		All IO = $3.3V_{DC}$
	$I_{DD2 (Q)}$		1.2	1.8	mA		

Table 8. Switching Specifications

V_{DD1} - V_{GND1} = V_{DD2} - V_{GND2} =3.0V ~ 5.5V, typical value is measured at T_A=25°C, unless otherwise noted.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
Output Signal Fall Time SDA1, SCL1	t_{f1}	10	18	32	ns	0.9 × V_{DD1} to 0.9V; R1 = 1500Ω, C1 = 40pF, @ $5V_{DC}$ supply
		8	16	30	ns	R1 = 1000Ω, C1 = 40pF; @ $3.3V_{DC}$ supply
Output Signal Fall Time SDA2, SCL2	t_{f2}	20	36	60	ns	0.9 × V_{DD2} to 0.4V; R2 = 150Ω, C2 = 400pF, @ $5V_{DC}$ supply
		18	31	57	ns	R2 = 100Ω, C2 = 400pF; @ $3.3V_{DC}$ supply
Low-to-High Propagation Delay, Side 1 to Side 2	t_{pLH1-2}		45	68	ns	0.55V to 0.7 × V_{DD2}; R1 = 1500Ω, R2 = 150Ω, C1, C2 = 10 pF; @ $5V_{DC}$ supply
			38	63	ns	R1 = 1000Ω, R2 = 100Ω, C1, C2 = 10pF; @ $3.3V_{DC}$ supply
High-to-Low Propagation Delay, Side 1 to Side 2	t_{PHL1-2}		67	130	ns	0.7V to 0.4V; R1 = 1500Ω, R2 = 150Ω, C1, C2 = 10pF; @ $5V_{DC}$ supply
			64	130	ns	R1 = 1000Ω, R2 = 100Ω, C1, C2 = 10pF; @ $3.3V_{DC}$ supply
Pulse Width Distortion $\lvert t_{pHL1-2} - t_{pLH1-2} \rvert$	PWD_{1-2}		22	60	ns	R1 = 1500Ω, R2 = 150Ω, C1, C2 = 10pF; @ $5V_{DC}$ supply
			26	65	ns	R1 = 1000Ω, R2 = 100Ω, C1, C2 = 10pF; @ $3.3V_{DC}$ supply
Low-to-High Propagation Delay, Side 2 to Side 1	t_{PLH2-1}		62	80	ns	0.4 × V_{DD2} to 0.7 × VDD1; R1 = 1500Ω, R2 = 150Ω, C1, C2 = 10pF; @ $5V_{DC}$ supply
			50	70	ns	R1 = 1000Ω, R2 = 100Ω, C1, C2 = 10pF; @ $3.3V_{DC}$ supply
High-to-Low Propagation Delay, Side 2 to Side 1	t_{PHL2-1}		54	84	ns	0.4 × V_{DD2} to 0.9V; R1 = 1500Ω, R2 = 150Ω, C1, C2 = 10pF; @ $5V_{DC}$ supply
			56	86	ns	R1 = 1000Ω, R2 = 100Ω, C1, C2 = 10pF; @ $3.3V_{DC}$ supply
Pulse Width Distortion $\lvert t_{pHL2-1} - t_{pLH2-1} \rvert$	PWD_{2-1}		12	25	ns	R1 = 1500Ω, R2 = 150Ω, C1,2 = 10 pF; @ $5V_{DC}$ supply
			15	35	ns	R1 = 1000Ω, R2 = 100Ω, C1, C2 = 10 pF; @ $3.3V_{DC}$ supply
Round-trip propagation delay on Side 1	t_{LOOP1}		116	180	ns	0.4 V to 0.3 × V_{DD1}; R1 = 1500Ω, R2 = 150Ω, C1, C2 = 10 pF; @ $5V_{DC}$ supply
			98	162	ns	R1 = 1000Ω, R2 = 100Ω, C1, C2 = 10 pF; @ $3.3V_{DC}$ supply
Common-Mode Transient Immunity[2]	CMTI		120		kV/μs	V_{IN} = V_{DDx}[1] or 0V, V_{CM} = 1000 V.
ESD（HBM - Human body model）	ESD		±6		kV	

Insulation And Safety Related Specifications

Table 9. Insulation Specifications

Parameter	Symbol	Value	Unit	Test Conditions/Comments
Rated Dielectric Insulation Voltage	V_{ISO}	3000	V_{RMS}	1-minute duration, certificated
Minimum External Air Gap (Clearance)	CLR	≥4.0	mm	Measured from input terminals to output terminals, shortest distance through air
Minimum External Tracking (Creepage)	CRP	≥4.0	mm	Measured from input terminals to output terminals, shortest distance path along body
Minimum Internal Gap (Internal Clearance)	DTI	≥21	μm	Insulation distance through insulation
Tracking Resistance (Comparative Tracking Index)	CTI	≥400	V	DIN EN 60112 (VDE 0303-11):2010-05
Material Group		II		IEC 60112:2003 + A1:2009

Package Characteristics

Table 10.Package Characteristics

Parameter	Symbol	Value	Unit	Test Conditions/Comments
Resistance (Input to Output)[1]	R_{I-O}	$≥10^{12}$	Ω	V_{IO}=500V, T_A = 25°C
Resistance (Input to Output)[1]	R_{I-O}	$≥10^{11}$	Ω	V_{IO}=500V, T_A = 125°C
Resistance (Input to Output)[1]	R_{I-O}	$≥10^{9}$	Ω	V_{IO}=500V, T_A = 150℃
Capacitance (Input to Output)[1]	C_{I-O}	1.5	pF	@300kHz
Input Capacitance[2]	C_I	3	pF	@1MHz, ensured by design
IC Junction to Ambient Thermal Resistance	$θ_{JA}$	100	°C/W	

Notes:

1. The device is considered a 2-terminal device. Short-circuit all terminals on the VDD_1 side as one terminal and short-circuit all terminals on the VDD_2 side as the other terminal.
2. Testing from the input signal pin to ground.

DIN EN IEC 60747-17 (VDE 0884-17): 2021-10 Insulation Characteristics

Table 11.VDE Insulation Characteristics

Description	Test Conditions/ Comments	Symbol	Characteristic	Unit
Installation Classification per DIN VDE 0110				
For Rated Mains Voltage ≤ 150 V_{RMS}			I to IV	
For Rated Mains Voltage ≤ 300 V_{RMS}			I to III	
For Rated Mains Voltage ≤ 400 V_{RMS}			I to III	
Climatic Classification			40/125/21	
Pollution Degree per DIN VDE 0110, Table 1			2	
Maximum repetitive peak isolation voltage	Time dependent dielectric breakdown test	V_{IORM}	707	V_{peak}
Maximum isolation working voltage	AC voltage (sine wave)	V_{IOWM}	500	V_{RMS}
	DC Voltage		707	V_{peak}
Input to Output Test Voltage, Method B1				
100% production test, no pre-condition tests	V_{IORM} × 1.5 = $V_{pd\ (m)}$, t_{ini} = t_m = 1 sec, partial discharge < 5pC	$V_{pd\ (m)}$	1061	V_{peak}
Input to Output Test Voltage, Method A				
After Environmental Tests Subgroup 1	V_{IORM} × 1.3 = $V_{pd\ (m)}$, t_{ini} = 60 sec, t_m = 10 sec, partial discharge < 5pC	$V_{pd\ (m)}$	919	V_{peak}
After Input and/or Safety Test Subgroup 2 and Subgroup 3	V_{IORM} × 1.2 = $V_{pd\ (m)}$, t_{ini} = 60 sec, t_m = 10 sec, partial discharge < 5pC	$V_{pd\ (m)}$	848	V_{peak}
Highest Allowable Overvoltage	V_{TEST} = V_{IOTM} t = 60s (qualification); V_{TEST} =1.2 × V_{IOTM} t= 1s (100% production)	V_{IOTM}	4200	V_{peak}
Maximum Surge Isolation Voltage	Basic insulation, 1.2/50 µs combination wave, V_{TEST} = 1.3 × V_{IOSM} (qualification)[1]	V_{IOSM}	5000	V_{peak}
Safety Limiting Values	Maximum value allowed in the event of a failure (see Figure 4)			
Maximum Safety Temperature		T_S	150	℃
Maximum Power Dissipation at 25°C		P_S	1.25	W
Insulation Resistance	V_{IO} = 500V, T_A= 25°C	R_{I-O}	$\geq 10^{12}$	Ω
Insulation Resistance	V_{IO} = 500V, 100°C ≤ T_A ≤ 125°C	R_{I-O}	$\geq 10^{11}$	Ω
Insulation Resistance at T_S	V_{IO} = 500V, T_S = 150℃	R_{I-O}	$\geq 10^{9}$	Ω

Notes:

[1]In accordance with DIN V VDE V 0884-17, ISO1640BDR is proof tested by applying a surge isolation voltage of 6500V.

Typical Thermal Characteristics

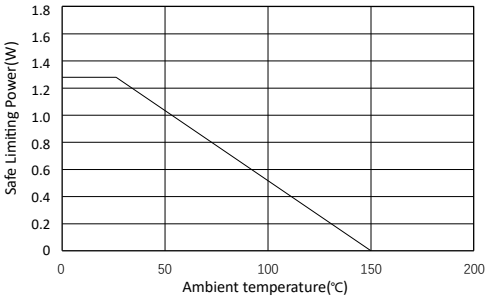


Figure 4.Thermal Derating Curve, Dependence Of Safety Limiting Values with Ambient Temperature per VDE

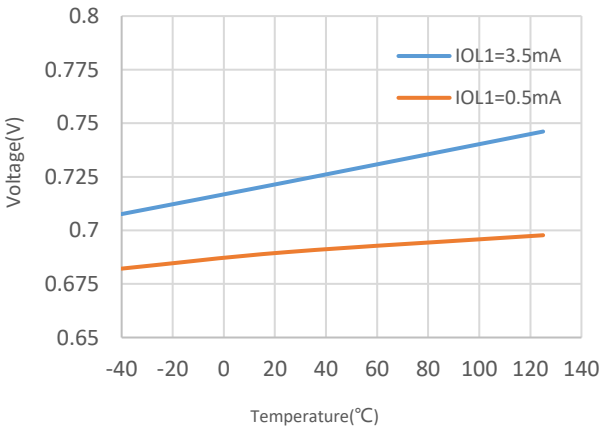


Figure 5. Side 1: Output Low Voltage vs Free-Air Temperature

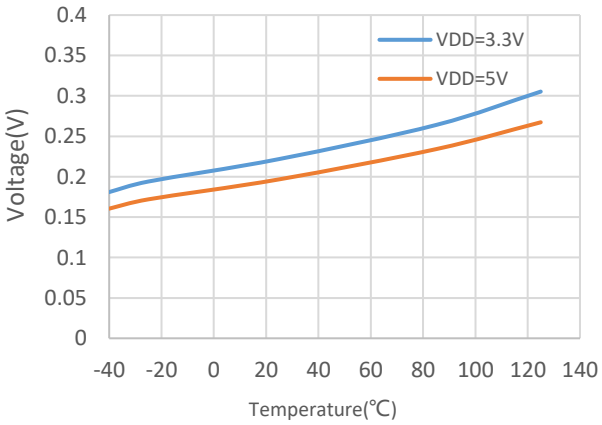


Figure 6. Side 2: Output Low Voltage vs Free-Air Temperature, Sink 35mA

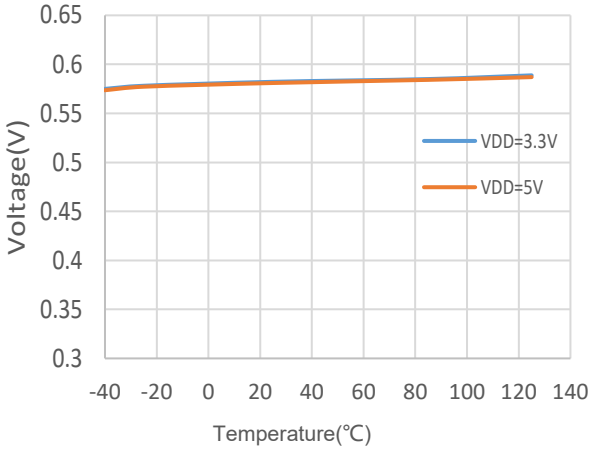


Figure 7. Side 1: Input Threshold High vs Free-Air Temperature

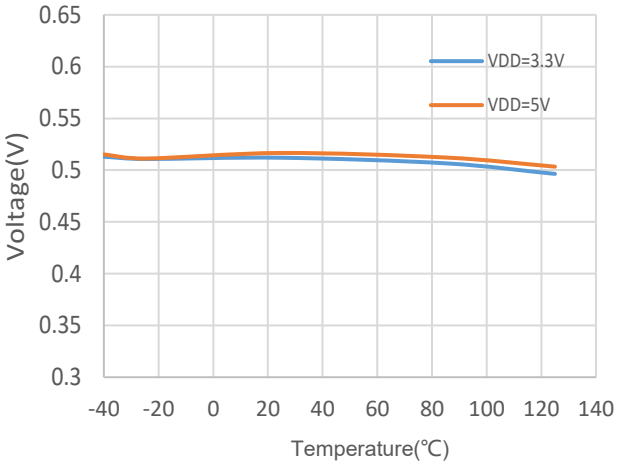


Figure 8. Side 1: Input Threshold Low vs Free-Air Temperature

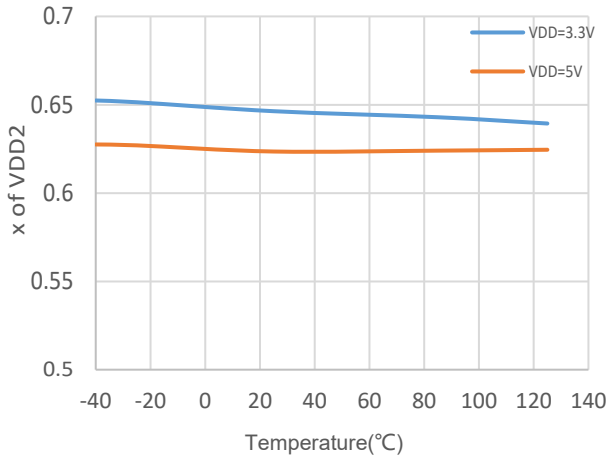


Figure 9 . Side 2: Input Threshold High vs Free-Air Temperature

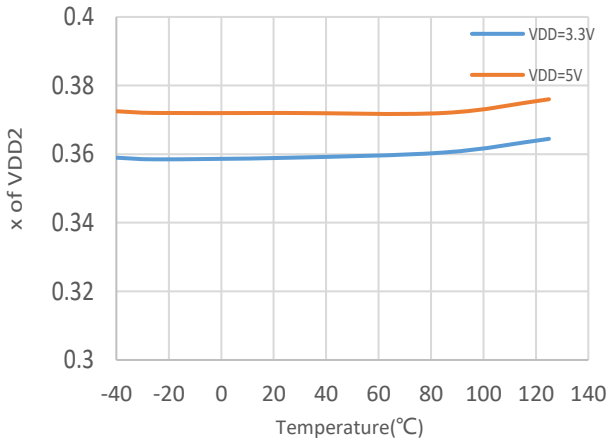


Figure 10. Side 2: Input Threshold Low vs Free-Air Temperature

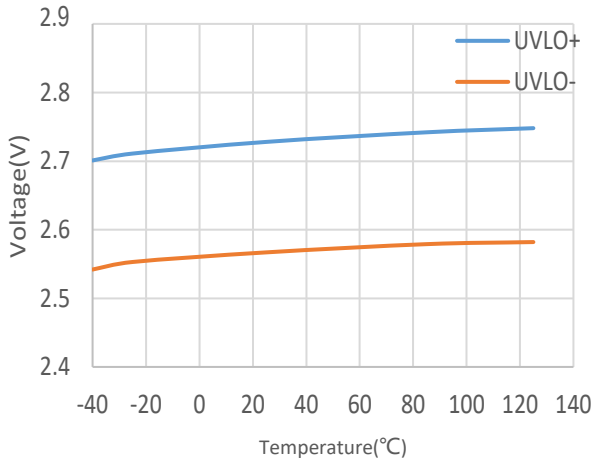


Figure 11 UVLO vs Free-Air Temperature

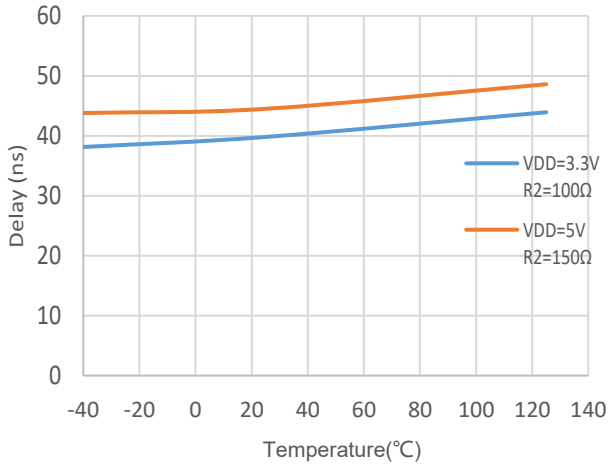


Figure 12. t_{PLH1-2} Propagation Delay vs Free-Air Temperature

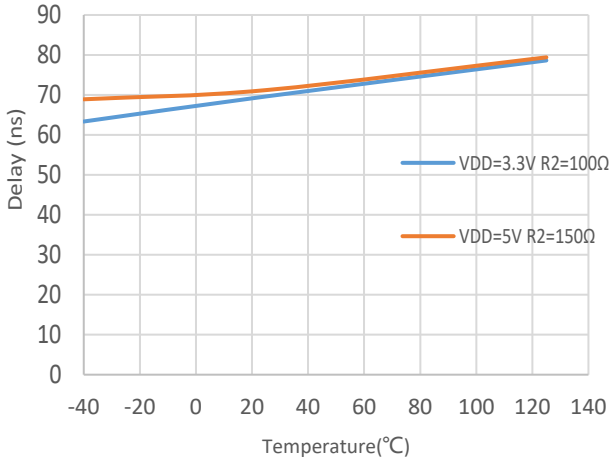


Figure 13. t_{PHL1-2} Propagation Delay vs Free-Air Temperature

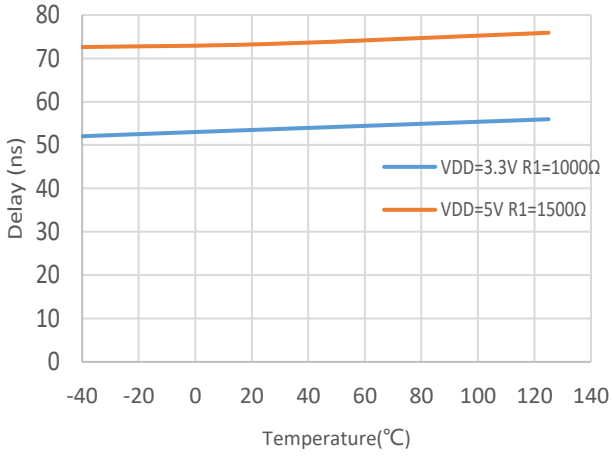


Figure 14. t_{PLH2-1} Propagation Delay vs Free-Air Temperature

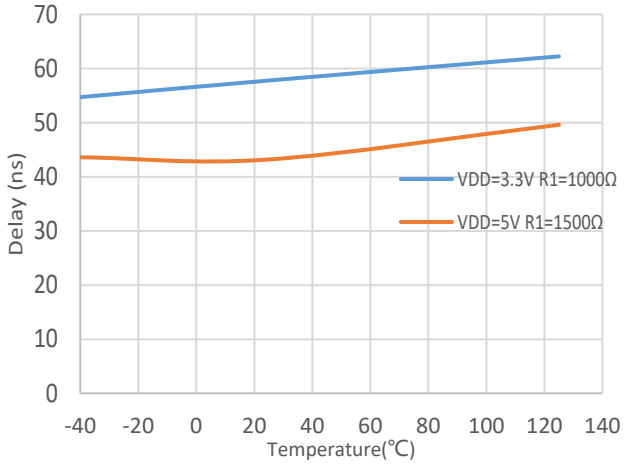


Figure 15. t_{PHL2-1} Propagation Delay vs Free-Air Temperature

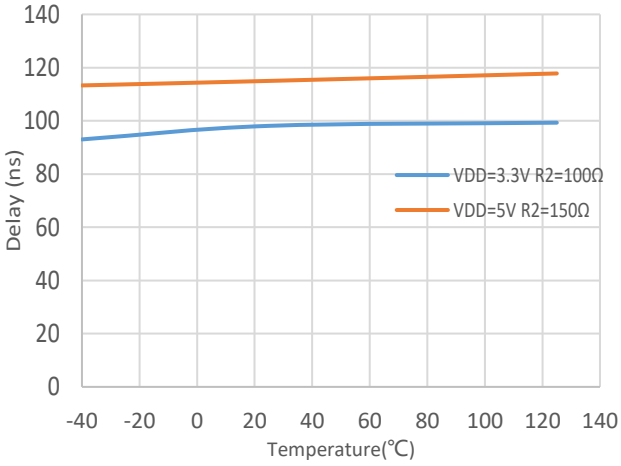


Figure 16. t_{LOOP1} vs Free-Air Temperature

Timing Test Information

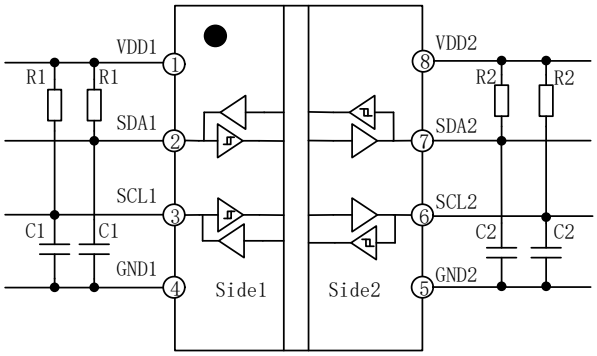


Figure 17. Test Diagram

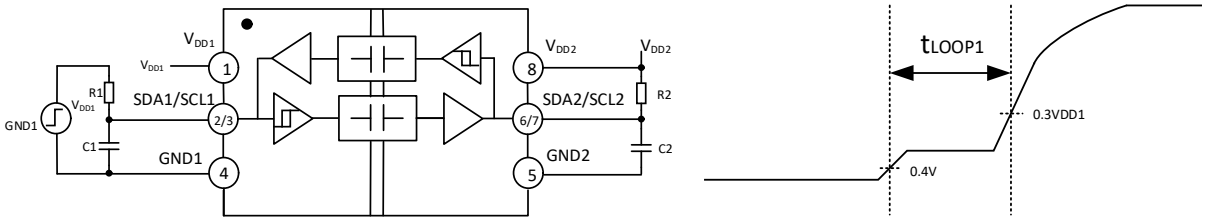


Figure 18. t_{Loop1} Setup and Timing Diagram

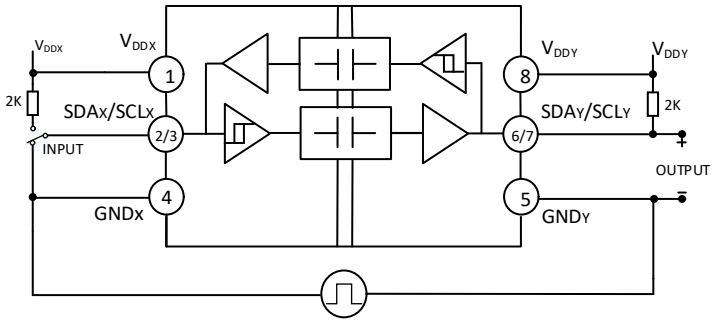


Figure 19. Common-Mode Transient Immunity Test Circuit

Applications Information

Overview

The inter-integrated circuit (I²C) bus is a single-ended, two wire bus for efficient inter-IC communication and is used in a wide range of applications. The I²C bus is used for communication between multiple masters or a single master and slaves. The master device controls the serial clock line (SCL), and data is bidirectional transferred on the serial data line (SDA) between master and slaves. The I²C bus can theoretically add up to 112 communication nodes, however, the number of nodes will increase the load capacitance on the bus, thereby limiting the communication distances and communication speeds. In applications, tradeoffs are often made between communication speeds, bus length, and number of nodes based on actual conditions.

The I²C bus supports data transmission in four speeds: standard mode (up to 100Kbps), fast mode (up to 400Kbps), fast mode plus (up to 1Mbps), and high-speed mode (up to 3.4Mbps). The ISO1640BDR device support all the above four communication modes.

Functional Description

The ISO1640BDR device is low-power bidirectional isolators compatible with the I²C interface.

This device have logic input and output buffers that are separated by using a silicon dioxide (SiO_2) barrier. This device block high voltages and prevent noise currents from entering the control side ground, avoiding circuit interference, and damaging sensitive components.

Each channel output of the ISO1640BDR device is made open-drain to comply with the open-drain technology of I²C. Serial data line (SDA)and serial clock line (SCL) need to add pull-up resistors to ensure normal operation of the system. It is recommended that side 1 of the I²C isolator be connected to the processor and sides 2 to the bus when there are multiple nodes on the I2C bus as side 2 support up to 400pF capacitance load.

The ISO1640BDRdevice feature two bidirectional channels that have open-drain outputs, As shown in Figure 20. As a logic low on one side causes the corresponding pin on the other side to be pulled low, to avoid data-latching within the device, The output logic low (V_{OL1}) voltages of SDA_1 and SCL_1 are at least 60mV higher than the input threshold high (V_{IHT1}) of SDA_1 and SCL_1, As shown in Figure 21.

Because the Side 2 logic levels/thresholds are standard I²C values, multiple ISO1640BDR devices connected to a bus by their Side 2 pins can communicate with each other and with other I2C compatible devices. However, because the Side 1 pin has a modified output level/ input threshold, this side of the ISO1640BDR can communicate only with devices that conform to the I2C standard.

The output low voltages of ISO1640BDR device is guaranteed for sink currents of up to 35mA for side 2, and 3. 5mA for side 1.

To enhance system reliability, it is recommended to connect the node with larger load capacitance and longer wires on side 2 for point-to-point communication.

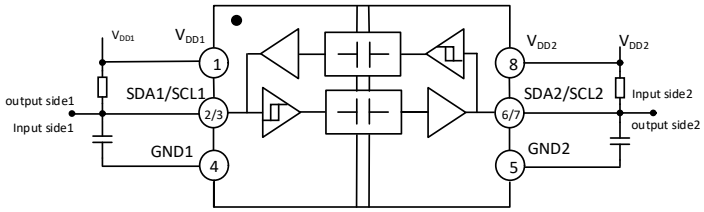


Figure 20. system operation diagram

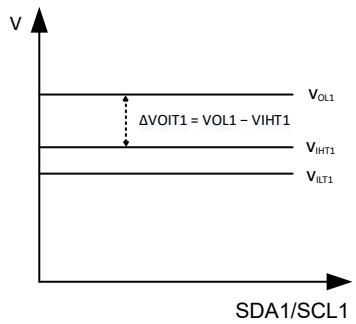


Figure 21. side 1 voltage Diagram

Typical Application Diagram

Figure 22 shows a typical application circuit including the pull-up resistors required for both Side 1 and Side 2. Bypass capacitors with values from 0.1μF to 10μF are required between VDD1 and GND1 and between VDD2 and GND2. To enhance the robustness of a design, the user may connect a resistor (50-200Ω) in series between R2 and C1 and between R3 and C2 if the system is excessively noisy.

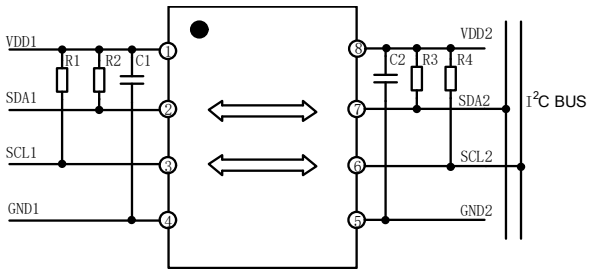


Figure 22. Typical Isolated I²C Interface Using the ISO1640BDR

Outline Dimensions

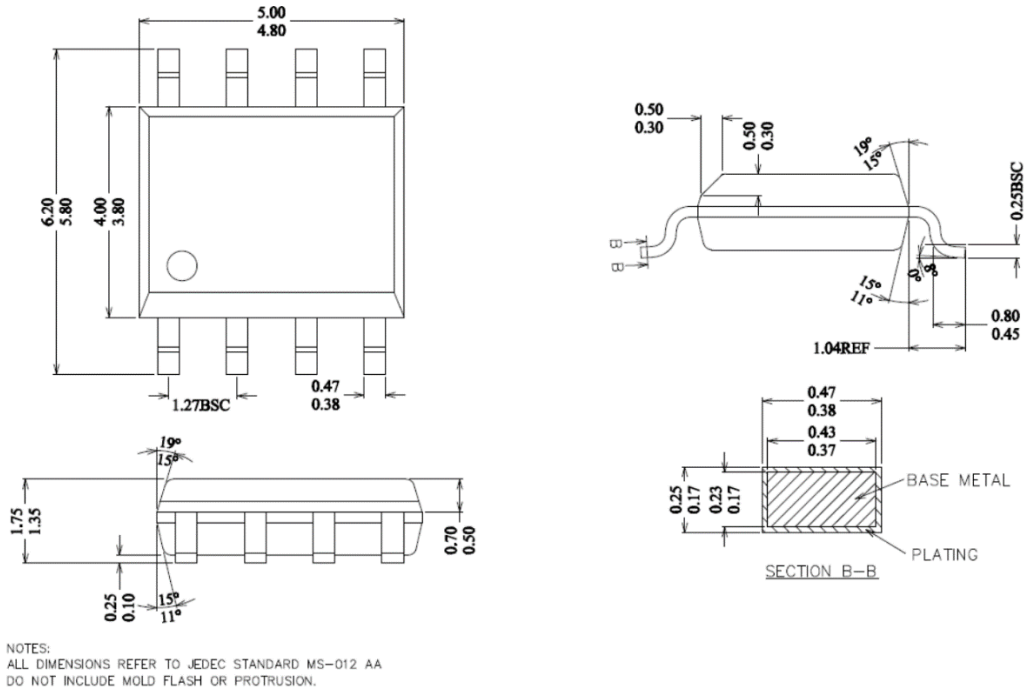


Figure 23. 8-Lead SOP Outline Package–dimension unit(mm)

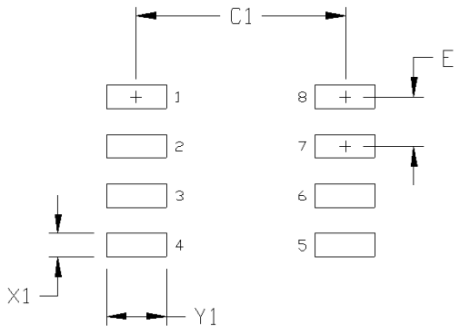


*Figure 24.*8-Lead SOP Land Pattern

Table 12.8-Lead SOP Land Pattern Dimensions

Dimension	Feature	Parameter	Unit
C1	Pad column spacing	5.40	mm
E	Pad row pitch	1.27	mm
X1	Pad width	0.60	mm
Y1	Pad length	1.55	mm

Note：

1.This land pattern design is based on IPC -7351.

2.All feature sizes shown are at maximum material condition and a card fabrication tolerance of 0.05 mm is assumed.

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