

英飞凌 ISOFACE™ 4DIRx4xxHA 系列

通过 AEC-Q100 认证的坚固耐用的数字隔离器

描述

英飞凌 ISOFACE™ 4DIRx4xxHA 四通道数字隔离器系列通过了 AEC-Q100 汽车应用认证。它支持高达 40 Mbps 的数据传输速率，并确保在宽泛的环境工作温度范围（-40°C 至 +125°C）内确保稳健的数据通信。英飞凌坚固耐用的无芯变压器（CT）技术具有很高的系统抗噪能力（CMTI 最小 100 kV/μs），并可承受高达 5700 V_{rms} 隔离电压（V_{ISO}）。PG-DSO-16 宽体 300 mil 封装中的四个数据通道可简化设计并实现高功率密度，并在低功耗下提高系统效率。另外还提供具有不同通道配置和故障安全默认输出状态的产品版本。

特性

- 通过 AEC-Q100 1 级（-40°C 至 +125°C）环境工作温度范围认证
- 数据速率高达 40 Mbps
- 宽工作电源电压 2.7 V - 6.5 V
- 低电流消耗 (最大值为 1.6 mA/通道 @ 1 Mbps、3.3 V、15 pF)
- 高 CMTI，最低值为 100 kV/μs
- 传播延迟典型值为 26 ns，通道间失配为 3 ns
- 3.3 V 时最大脉冲宽度失真为 3 ns
- 可变 CMOS 输入阈值，具有默认输出高或低选项
- 符合 RoHS 标准的 PG-DSO-16 宽体 300 mil 封装



隔离和安全证书

- UL 1577（第 5 版），V_{ISO} = 5700 V_{rms}（认证编号 E311313）
- IEC 62368-1、IEC 60601-1、IEC 61010-1、GB 4943.1 体系标准的 EN 和 CQC 认证¹⁾

产品验证

汽车应用认证。产品依据 AEC-Q100 进行验证。

潜在应用

- 隔离串行外设接口 (SPI)
- 混合动力、电动和动力总成系统（电动汽车/混合动力车）
 - 车载充电器（OBC）
 - 牵引逆变器
 - 直流/直流转换器
 - 变频器和电机控制

¹ 认证计划

本数据手册的原文使用英文撰写。为方便起见，英飞凌提供了译文；由于翻译过程中可能使用了自动化工具，英飞凌不保证译文的准确性。为确保准确性，请务必访问 infineon.com 参考最新的英文版本（控制文档）。

ISOFACE™ 4DIRx4xxHA 产品组合

Part number	Channel configuration	Default output state	Output enable	Isolation rating	Package
4DIR0400HA	4 forward 0 reverse (4+0)	Low	Active-high	$V_{ISO} = 5700 V_{rms}$ (UL1577 Ed. 5)	PG-DSO-16 wide-body 300 mil 10.3 x 10.3 mm
4DIR0401HA		High			
4DIR1400HA	3 forward 1 reverse (3+1)	Low			
4DIR1401HA		High			
4DIR2400HA	2 forward 2 reverse (2+2)	Low			
4DIR2401HA		High			
4DIR1420HA	3 forward 1 reverse (3+1)	Low	Active-low ¹⁾		
4DIR1421HA		High			

1) 非常适合共享SPI总线

应用示例

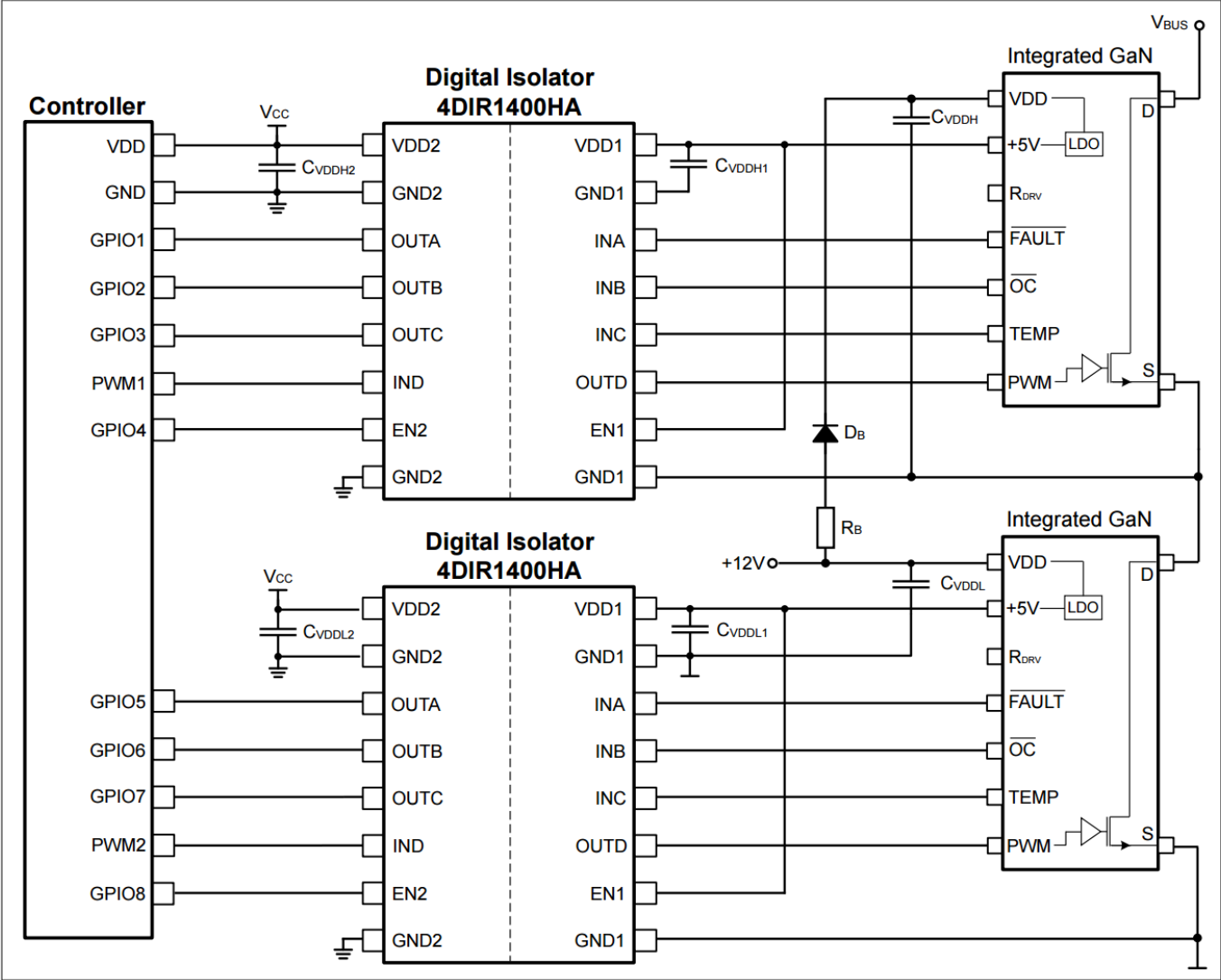


图1 使用GaN集成功率级（IPS）驱动半桥的典型应用

Application examples

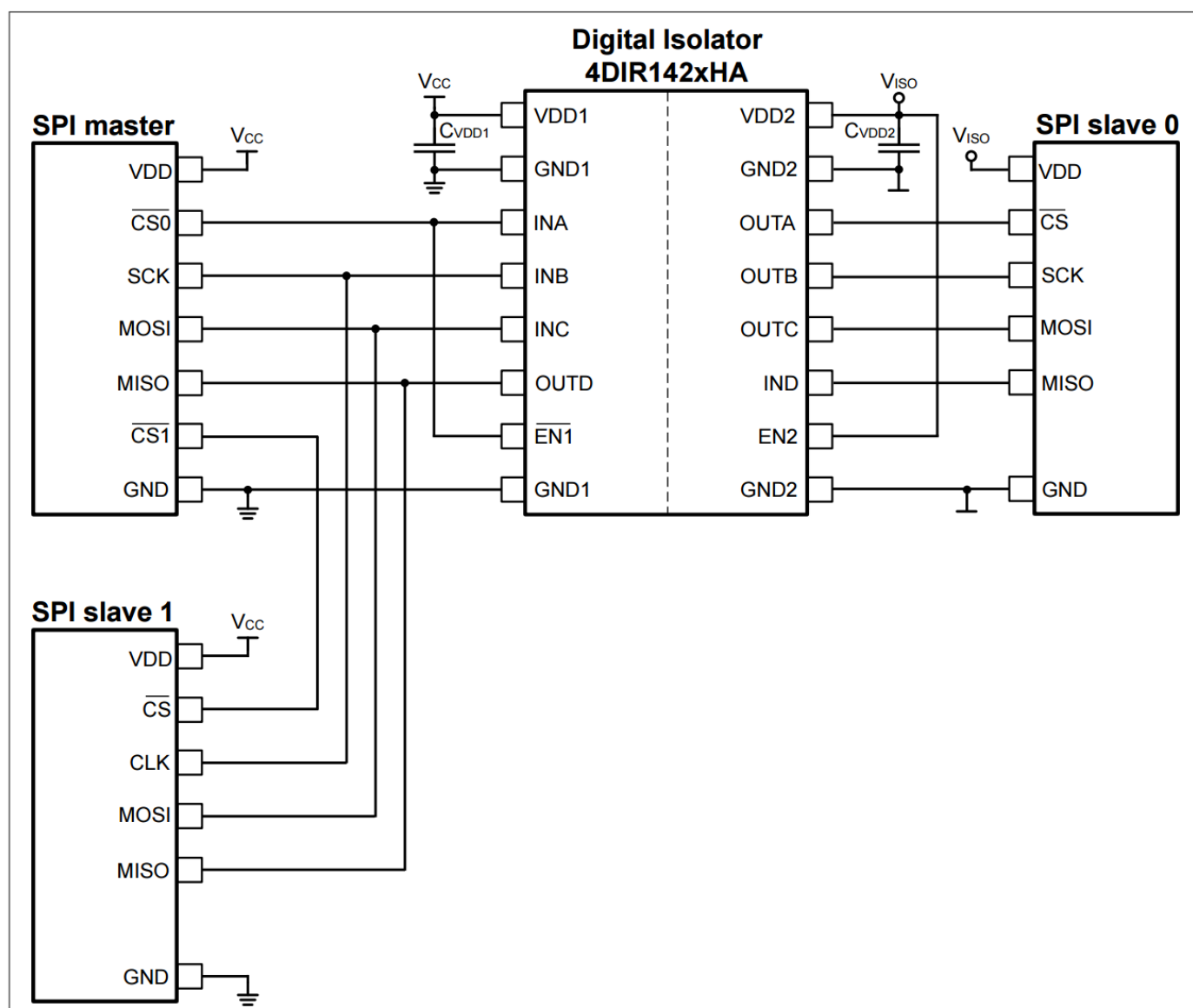


图2 **典型应用 - 隔离SPI总线**

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1 Functional block diagram

1 功能框图

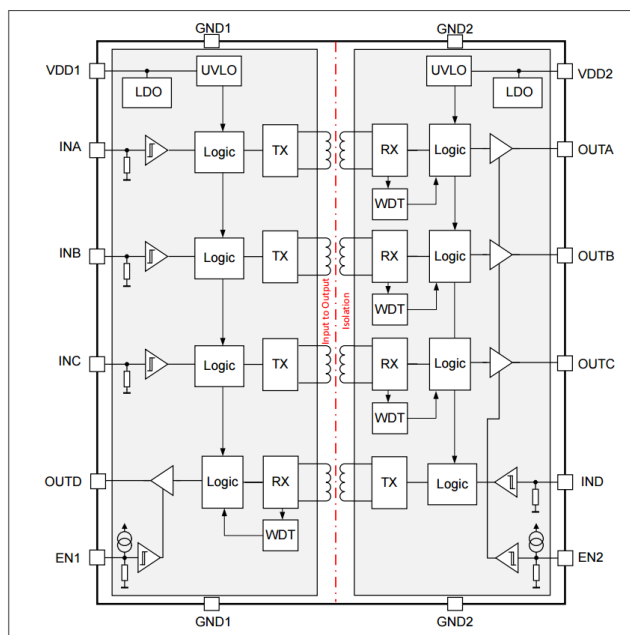


图 3 **3+1 数字隔离器**
(4DIR142xHA)

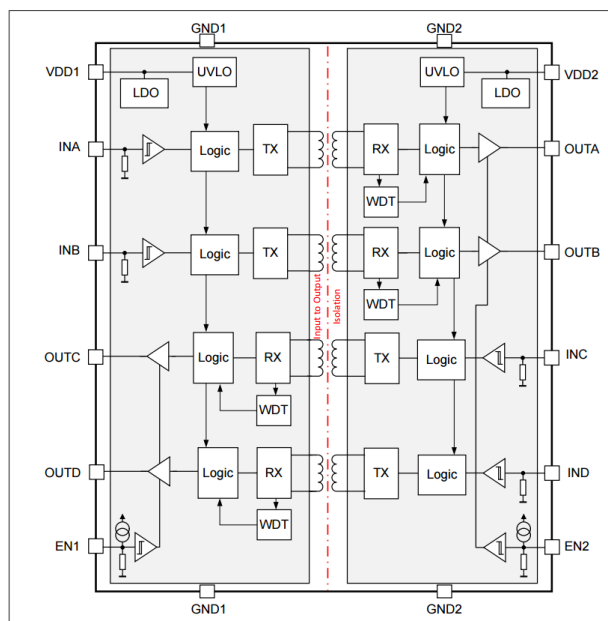


图 4 **2+2 数字隔离器**
(4DIR240xHA)

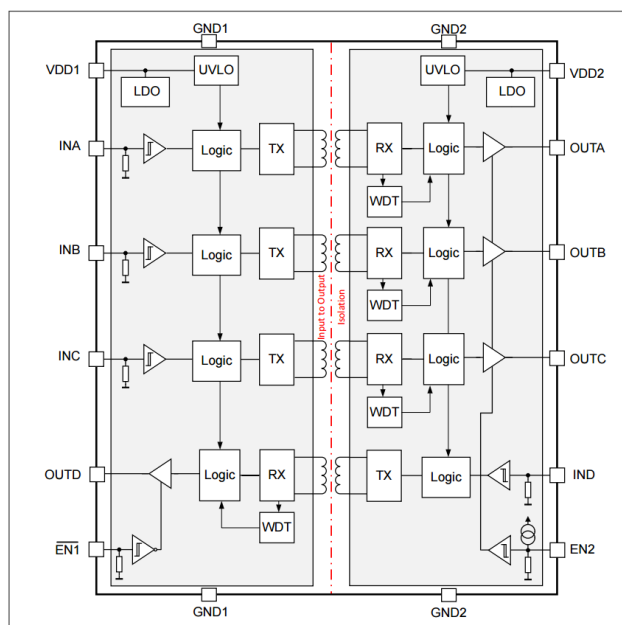


图 5 **3+1 EN1 neg. 数字隔离器**
(4DIR142xHA)

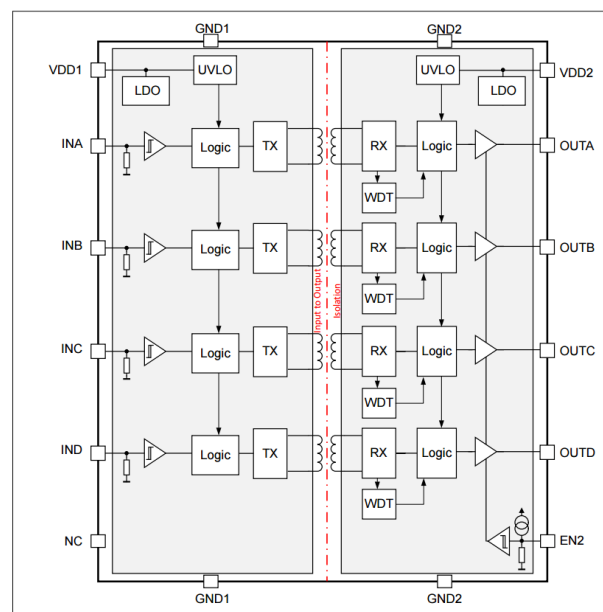


图 6 **4+0 数字隔离器**
(4DIR040xHA)

4DIR142xHA 的 1 侧 (EN1) 的输出使能信号为低电平有效，这使其非常适合隔离共享 SPI 总线上的端口，因为 CS 信号可以直接启用隔离器上的 MISO 信号。

2 Pin configuration

2 引脚配置

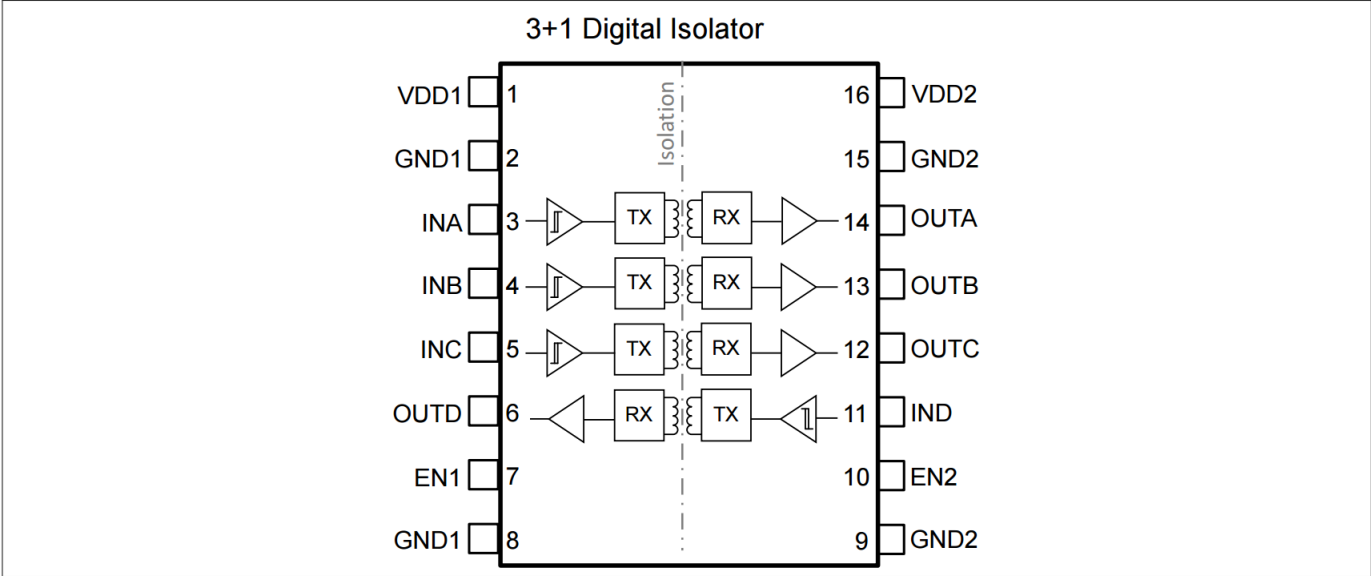


图 7 4DIR140xHA 引脚排列

表 1 4DIR140xHA 的引脚定义和功能

Name	Pin	Type	Function
VDD1	1	I	Positive supply voltage 1
GND1	2	-	Ground 1
INA	3	I	Channel A input
INB	4	I	Channel B input
INC	5	I	Channel C input
OUTD	6	O	Channel D output
EN1	7	I	Enable 1 (internally pulled-up). Output pins on side 1 are enabled when EN1 is high or open and in high-impedance state when EN1 is low. Do not leave open. Connect to VDD1 to enable outputs or to GND1 to put outputs in high-impedance
GND1	8	-	Ground 1
GND2	9	-	Ground 2
EN2	10	I	Enable 2 (internally pulled-up). Output pins on side 2 are enabled when EN2 is high or open and in high-impedance state when EN2 is low. Do not leave open. Connect to VDD2 to enable outputs or to GND2 to put outputs in high-impedance
IND	11	I	Channel D input
OUTC	12	O	Channel C output
OUTB	13	O	Channel B output
OUTA	14	O	Channel A output
GND2	15	-	Ground 2
VDD2	16	I	Positive supply voltage 2

ISOFACE™ 4DIRx4xxHA family

Robust digital isolators with AEC-Q100 qualification

2 Pin configuration

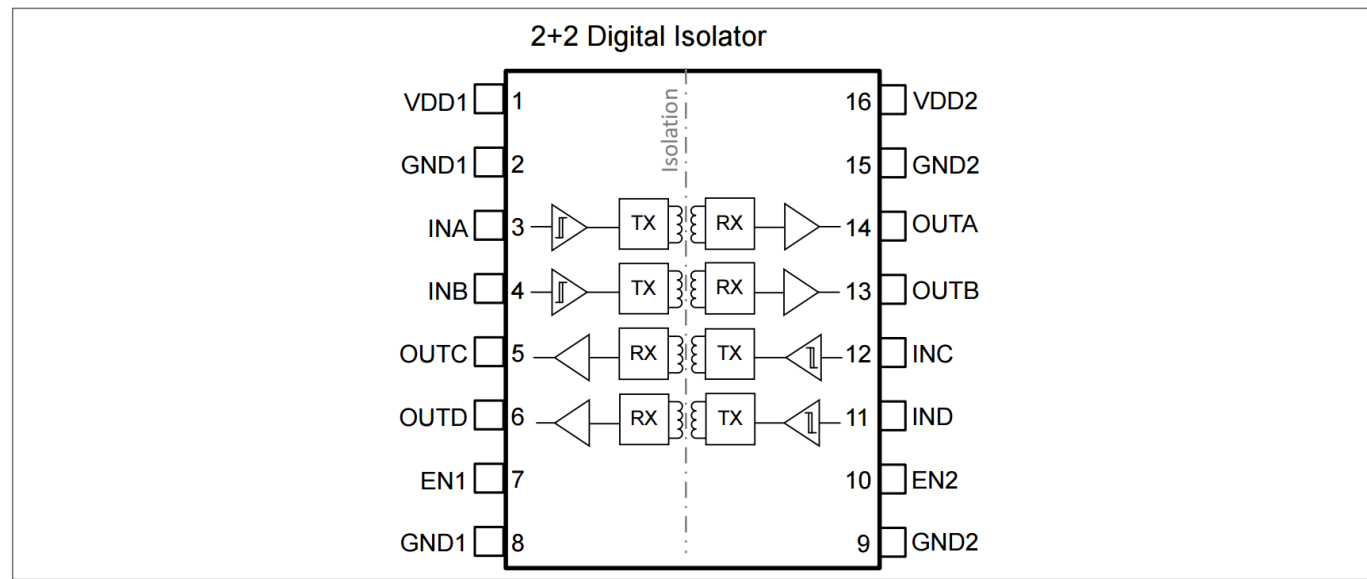


图 8 4DIR240xHA 引脚分布

表 2 4DIR240xHA 的引脚定义和功能

Name	Pin	Type	Function
VDD1	1	I	Positive supply voltage 1
GND1	2	-	Ground 1
INA	3	I	Channel A input
INB	4	I	Channel B input
OUTC	5	O	Channel C output
OUTD	6	O	Channel D output
EN1	7	I	Enable 1 (internally pulled-up). Output pins on side 1 are enabled when EN1 is high or open and in high-impedance state when EN1 is low. Do not leave open. Connect to VDD1 to enable outputs or to GND1 to put outputs in high-impedance
GND1	8	-	Ground 1
GND2	9	-	Ground 2
EN2	10	I	Enable 2 (internally pulled-up). Output pins on side 2 are enabled when EN2 is high or open and in high-impedance state when EN2 is low. Do not leave open. Connect to VDD2 to enable outputs or to GND2 to put outputs in high-impedance
IND	11	I	Channel D input
INC	12	I	Channel C input
OUTB	13	O	Channel B output
OUTA	14	O	Channel A output
GND2	15	-	Ground 2
VDD2	16	I	Positive supply voltage 2

2 Pin configuration

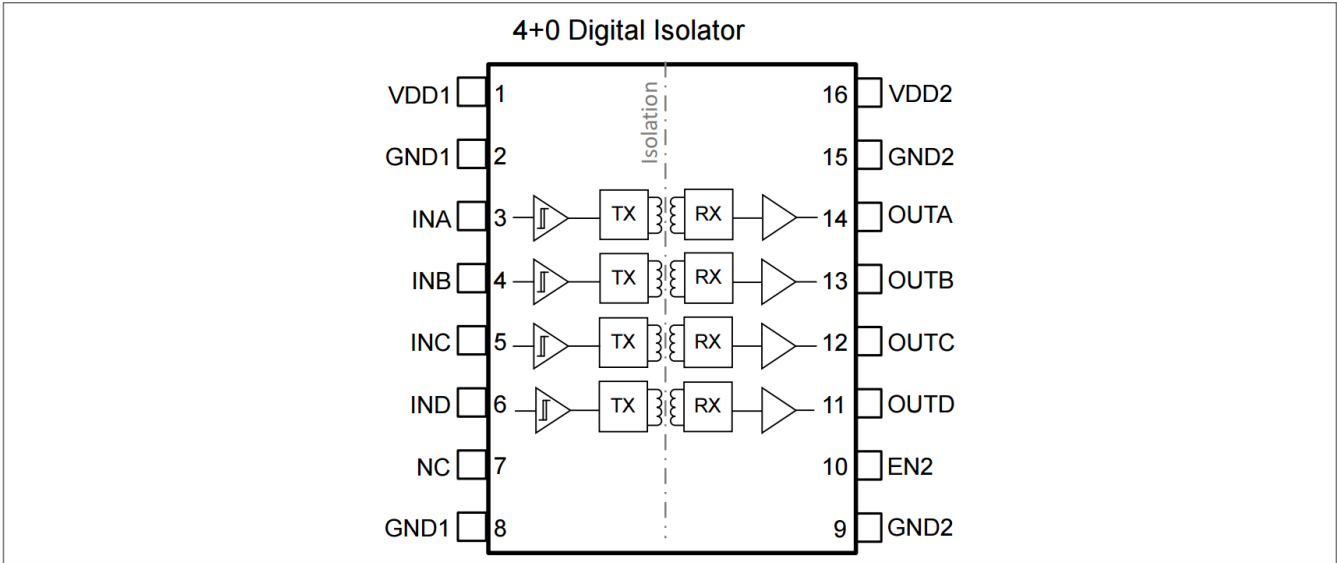


图 9 4DIR040xHA 引脚排列

表3 4DIR040xHA 的引脚定义和功能

Name	Pin	Type	Function
VDD1	1	I	Positive supply voltage 1
GND1	2	-	Ground 1
INA	3	I	Channel A input
INB	4	I	Channel B input
INC	5	I	Channel C input
IND	6	I	Channel D input
NC	7	-	No connect. Leave this pin floating
GND1	8	-	Ground 1
GND2	9	-	Ground 2
EN2	10	I	Enable 2 (internally pulled-up). Output pins on side 2 are enabled when EN2 is high or open and in high-impedance state when EN2 is low. Do not leave open. Connect to VDD2 to enable outputs or to GND2 to put outputs in high-impedance
OUTD	11	O	Channel D output
OUTC	12	O	Channel C output
OUTB	13	O	Channel B output
OUTA	14	O	Channel A output
GND2	15	-	Ground 2
VDD2	16	I	Positive supply voltage 2

2 Pin configuration

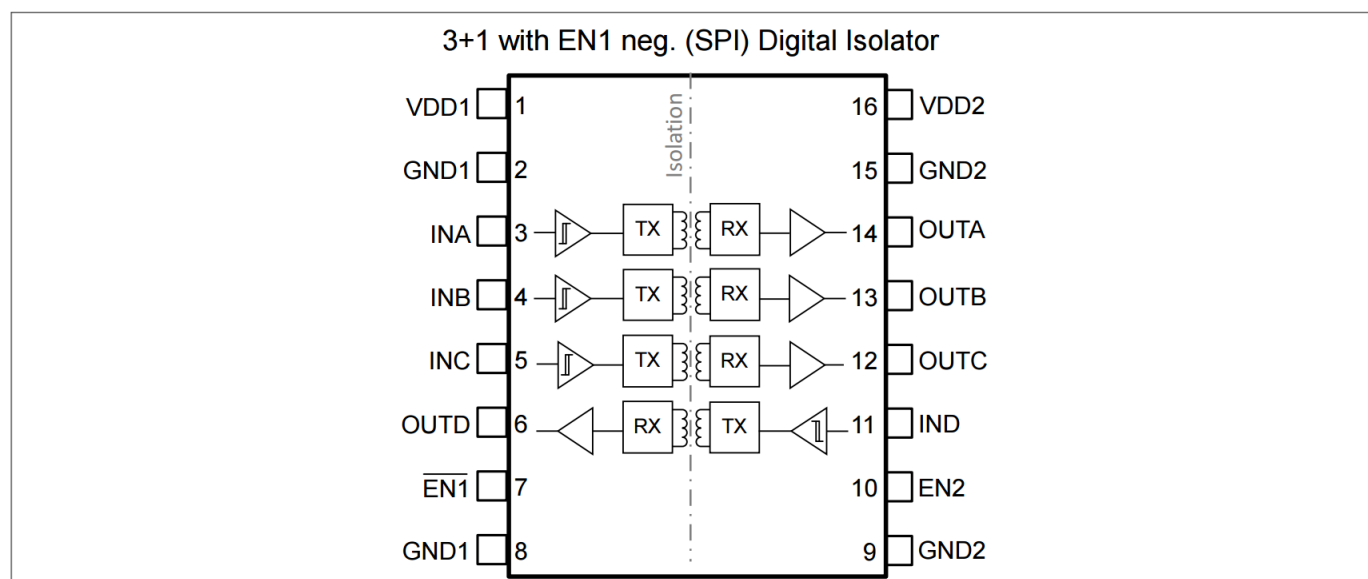


图 10 **4DIR142xHA 引脚分布**

表4 **4DIR142xHA 的引脚定义和功能**

Name	Pin	Type	Function
VDD1	1	I	Positive supply voltage 1
GND1	2	-	Ground 1
INA	3	I	Channel A input
INB	4	I	Channel B input
INC	5	I	Channel C input
OUTD	6	O	Channel D output
EN1	7	I	Negated enable <u>1</u> (internally pulled-down). Output pins on side 1 are enabled when EN1 is low or open and in high-impedance state when EN1 is high. Do not leave open. Connect to GND1 to enable outputs or to VDD1 to put outputs in high-impedance
GND1	8	-	Ground 1
GND2	9	-	Ground 2
EN2	10	I	Enable 2 (internally pulled-up). Output pins on side 2 are enabled when EN2 is high or open and in high-impedance state when EN2 is low. Do not leave open. Connect to VDD2 to enable outputs or to GND2 to put outputs in high-impedance
IND	11	I	Channel D input
OUTC	12	O	Channel C output
OUTB	13	O	Channel B output
OUTA	14	O	Channel A output
GND2	15	-	Ground 2
VDD2	16	I	Positive supply voltage 2

3 Functional description

3 功能描述

本章概述了集成的功能和特性，并描述了它们之间的关系。参数和公式基于 $T_A = 25^\circ\text{C}$ 时的典型值。

3.1 真值表

表5 4 通道数字隔离器真值表

V_{DDI}	V_{DDO}	$V_{ENX}^{1)}$	V_{INX}	V_{OUTX}
Powered	Powered	H or NC ²⁾	H	H
			L	L
		L	X ³⁾	Z ⁴⁾
Unpowered	Powered	H or NC	X	Default ⁵⁾
		L	X	Z
X	Unpowered	X	X	Z

1) EN1 控制 1 侧的输出，EN2 控制 2 侧的输出

2) 未连接

3) X 表示“不相关”

4) Z 表示“高阻抗”

5) 参考产品型号

表6 4 通道数字隔离器 (3+1 EN1 neg.) 真值表数字隔离器

V_{DDI}	V_{DDO}	$V_{EN1}^{1)}$	$V_{EN2}^{2)}$	V_{INX}	V_{OUTX}
Powered	Powered	L or NC	H or NC	H	H
				L	L
		H	L	X	Z
Unpowered	Powered	L or NC	H or NC	X	Default
		H	L	X	Z
X	Unpowered	X	X	X	Z

1) 控制 1 侧的输出

2) 控制 2 侧的输出

3 Functional description

3.2 时序图

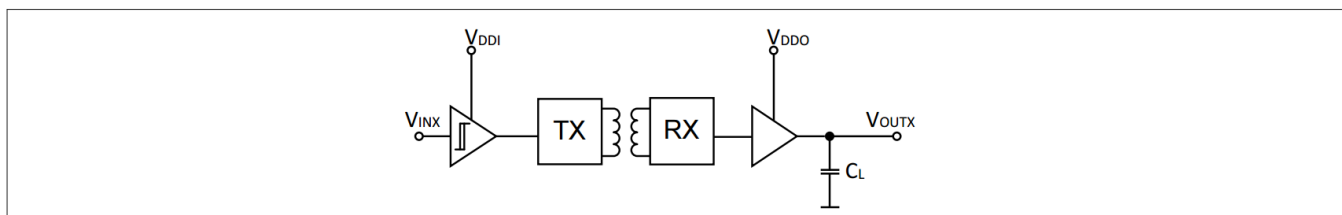


图11 测试电路

图 12 说明了在电容负载输出处观察到的输入到输出传播延迟。

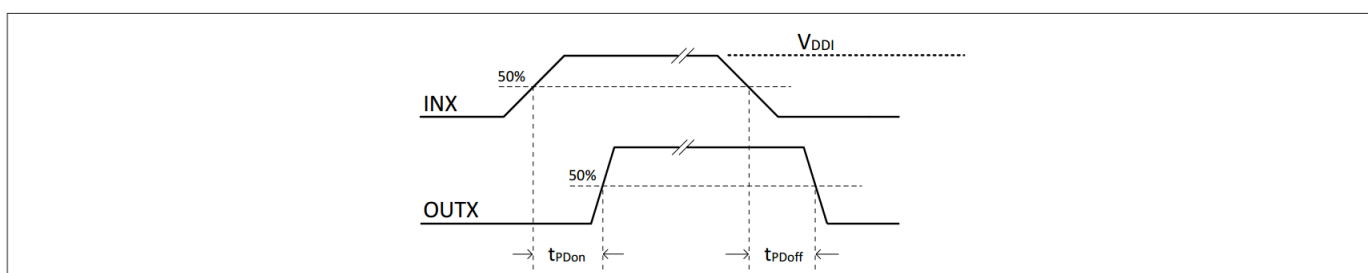


图12 传播延迟时间

图 13 说明了在电容负载输出处观察到的上升和下降时间。

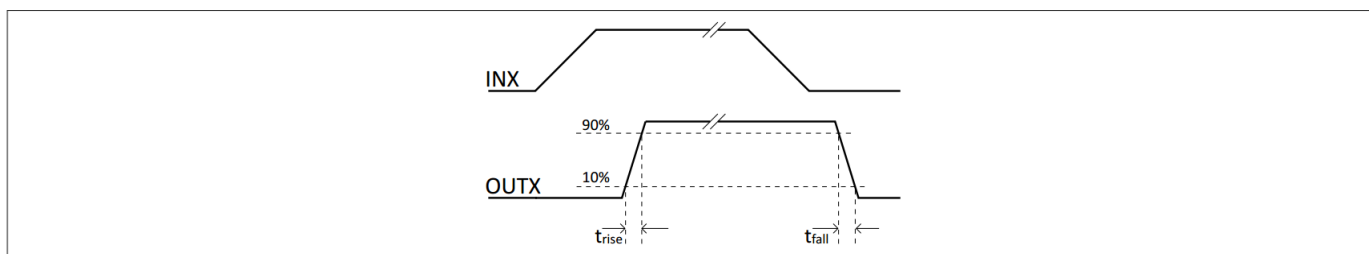


图13 上升、下降时间

图 14 显示了当 $V_{DD1/2}$ 在上升或下降转换(上电、断电、电源噪声) 期间超过UVLO阈值时，输出对电源UVLO的反应。注意，输入(V_{DD1}) 和输出 (V_{DD2}) 电源电压同时上升和下降。

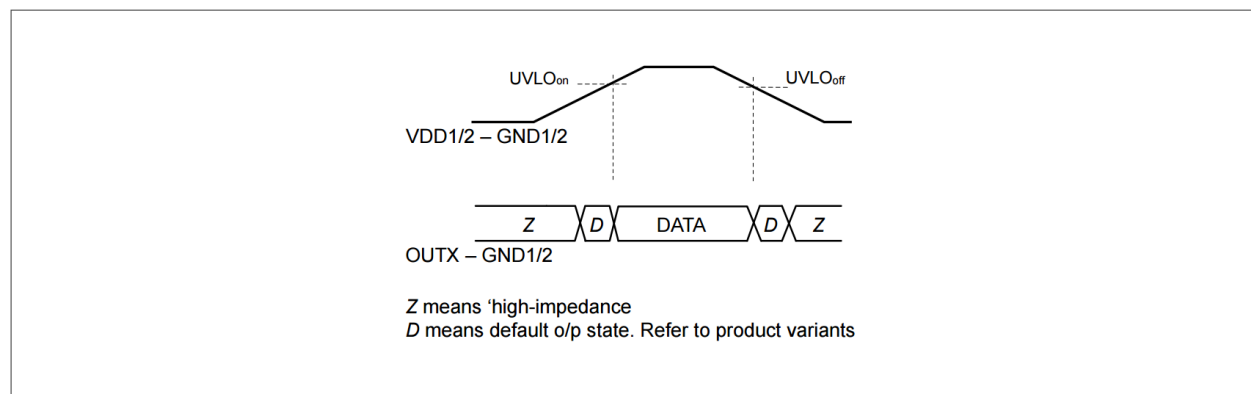


图 14 欠压锁定

图 15 展示出了输入信号之后 EN 信号的上升沿和下降沿到输出之间的传播延迟。

3 Functional description

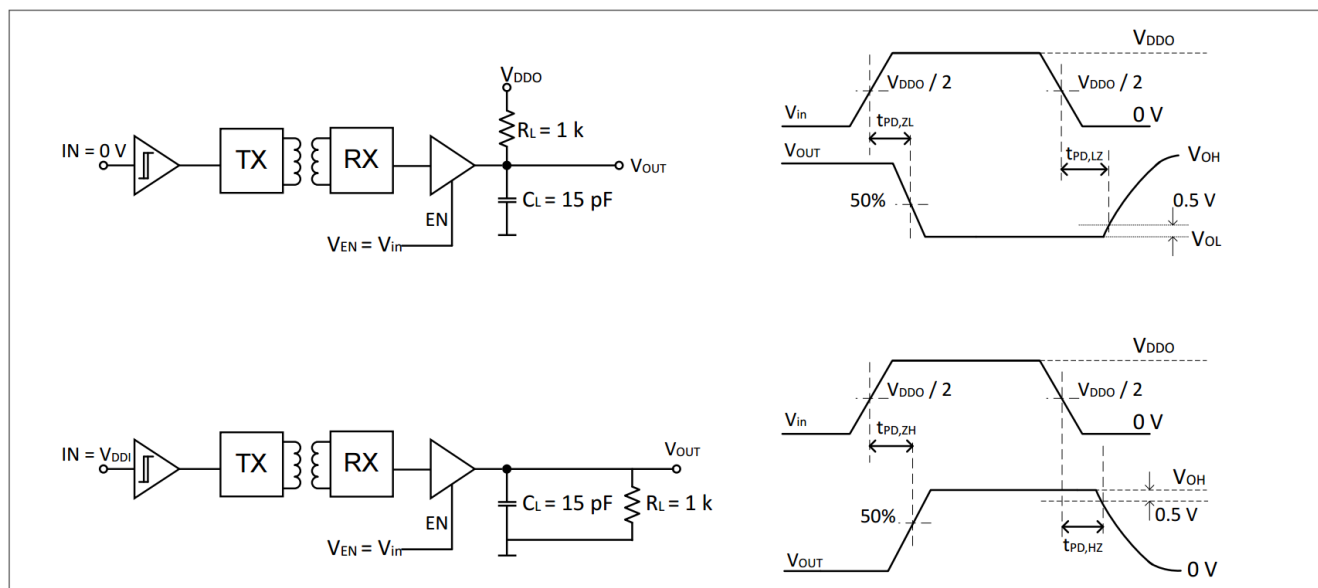


图 15 输出启用/禁用传播延迟

图 16 说明当输入失去供电时进入默认输出状态的时间。

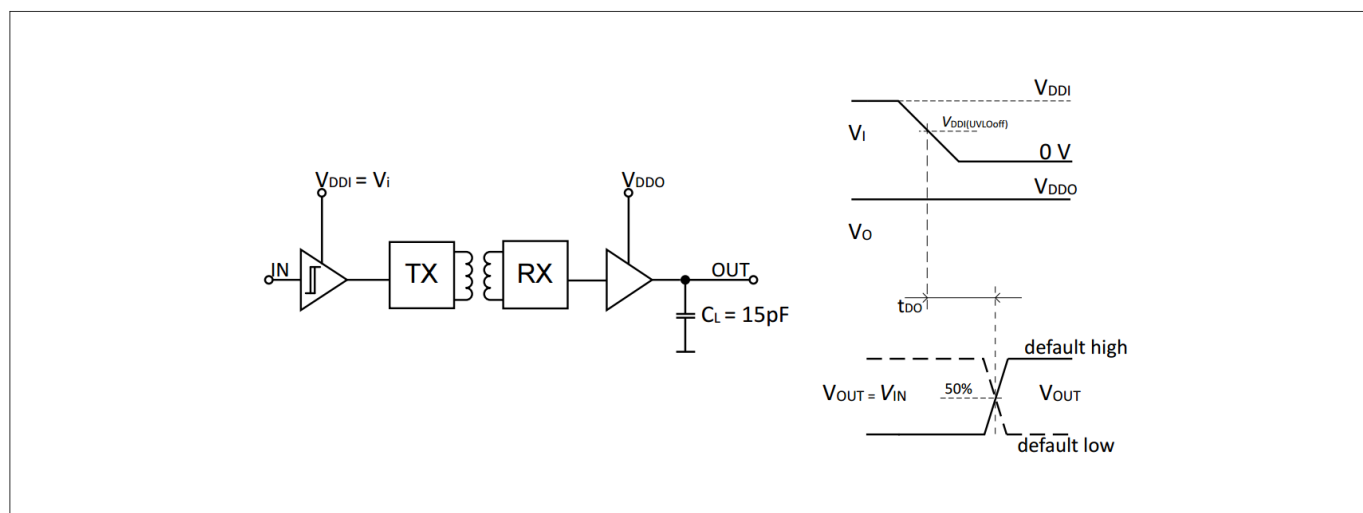
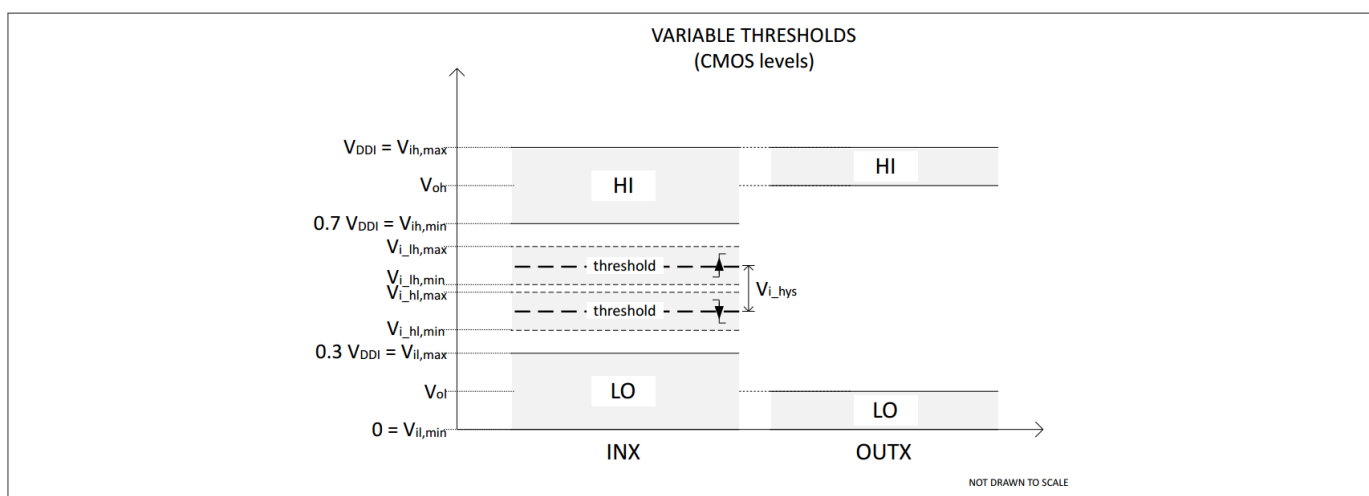


图 16 默认输出延迟时间

图 17 说明了当输入和输出侧电源具有不同的上电时间时的输出行为，其中上电时间为 $t_{PU} = \max\{t_{PU1}, t_{PU2}\}$ 。

[illegible]

3 Functional description

3.5 电源特性

最大值是在 $T_A = 125^\circ\text{C}$ 、 $C_{\text{LOAD}} = 15\text{ pF}$ 和50%占空比输入方波下给出的。

3+1数字隔离器 (4DIR140xHA)

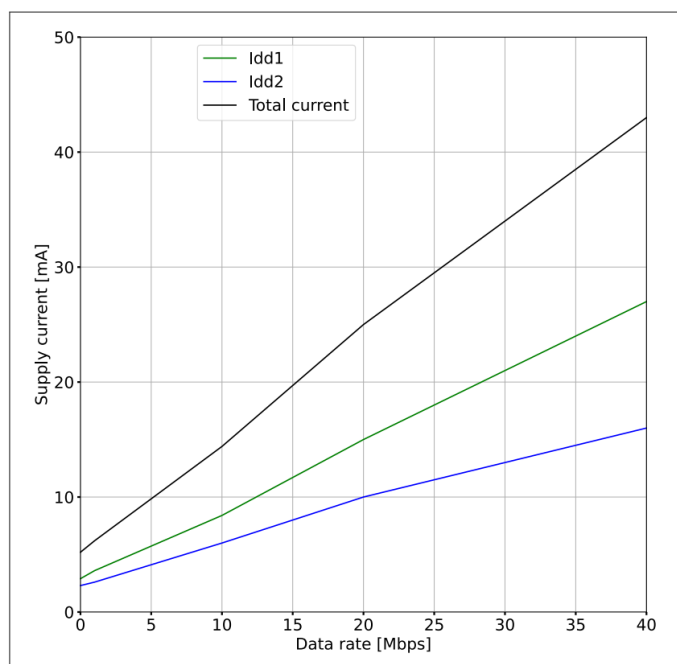


图 19 电源电流与数据速率的关系 ($V_{\text{DD1}} = V_{\text{DD2}} = 6.5\text{ V}$)

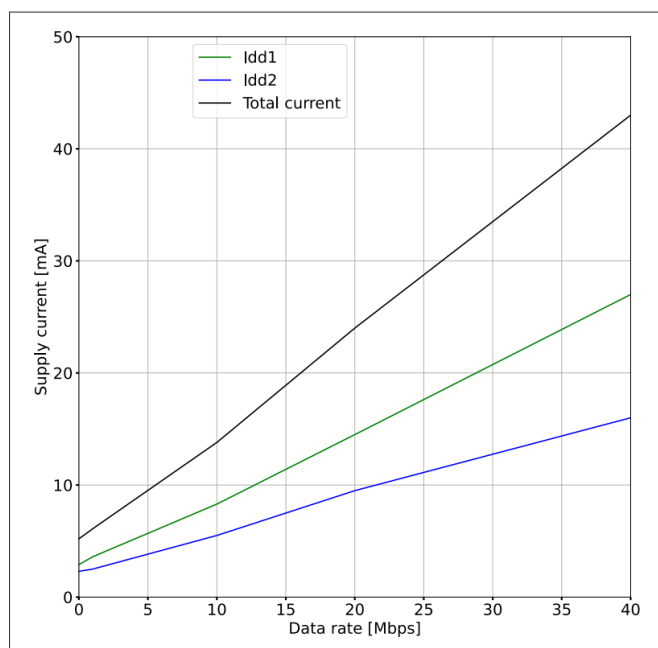


图 20 电源电流与数据速率的关系 ($V_{\text{DD1}} = V_{\text{DD2}} = 5.0\text{ V}$)

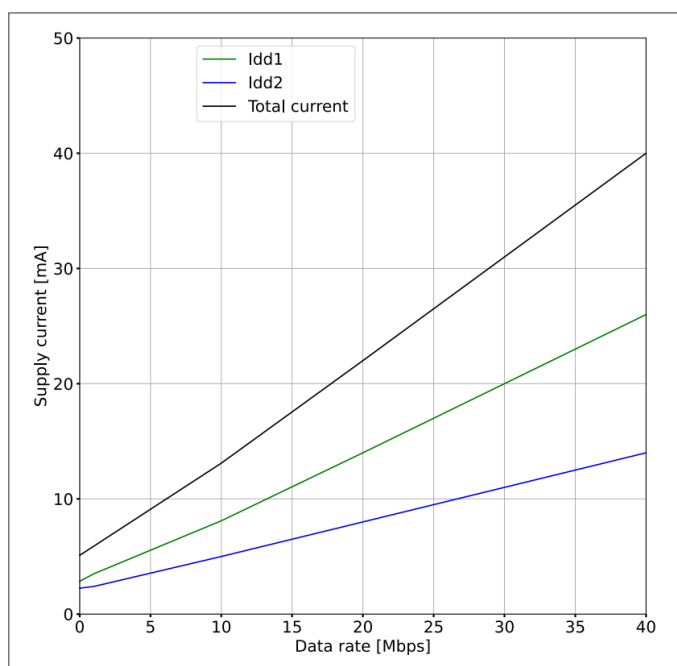


图 21 电源电流与数据速率的关系 ($V_{\text{DD1}} = V_{\text{DD2}} = 3.3\text{ V}$)

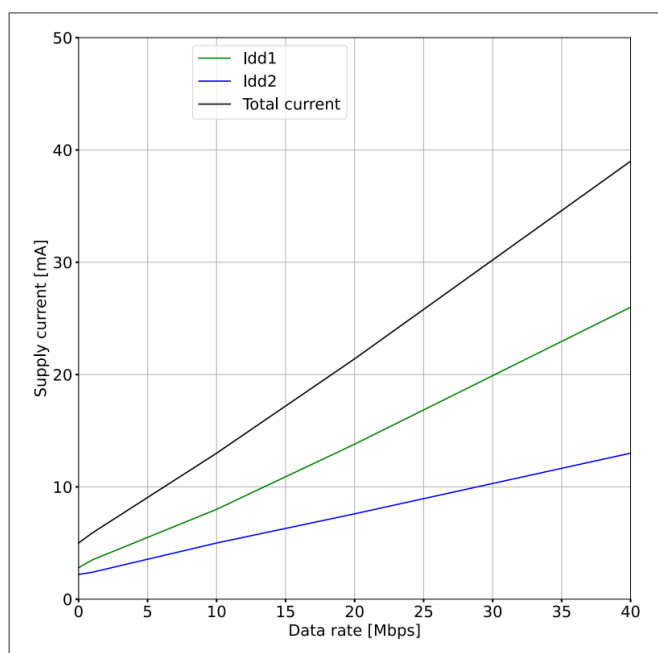


图 22 电源电流与数据速率的关系 ($V_{\text{DD1}} = V_{\text{DD2}} = 2.7\text{ V}$)

3 Functional description

3+1 EN1 neg. 数字隔离器 (4DIR142xHA)

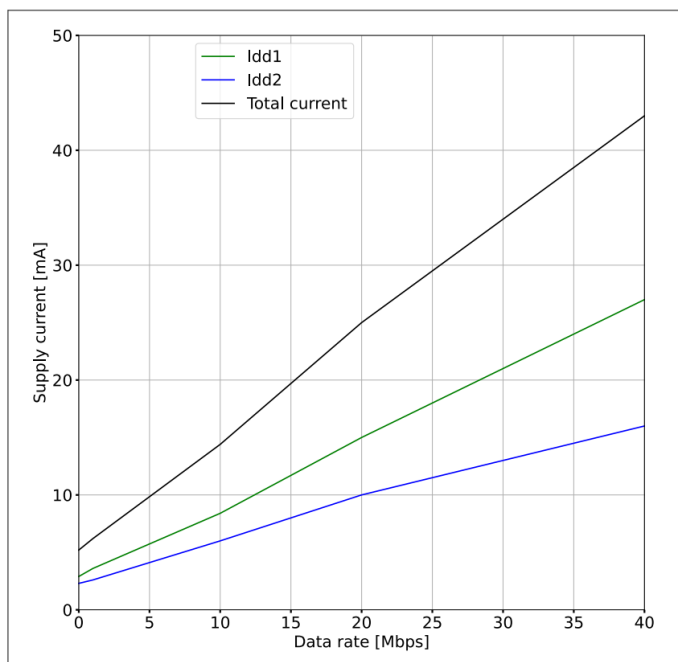


图 23 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 6.5 \text{ V}$)

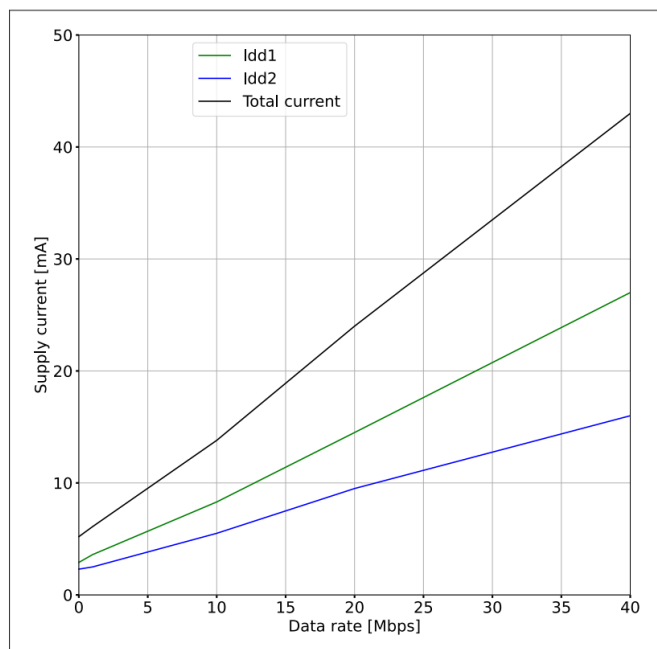


图 24 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 5 \text{ V}$)

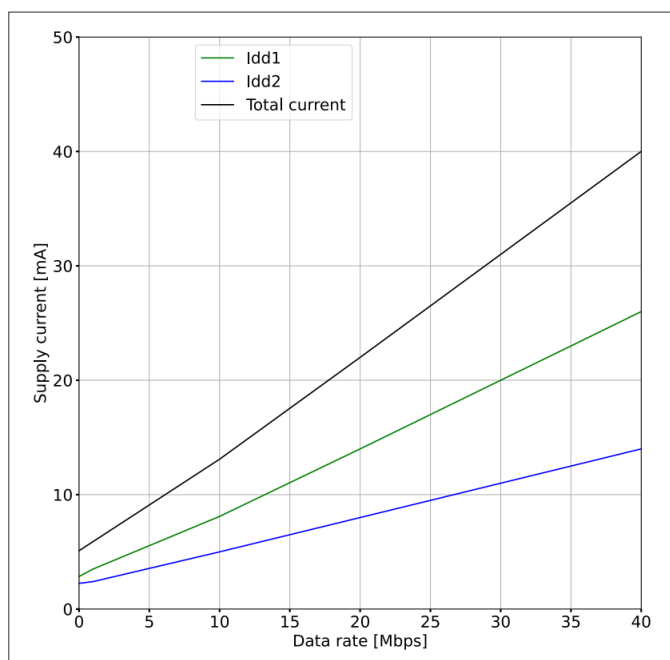


图 25 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 3.3 \text{ V}$)

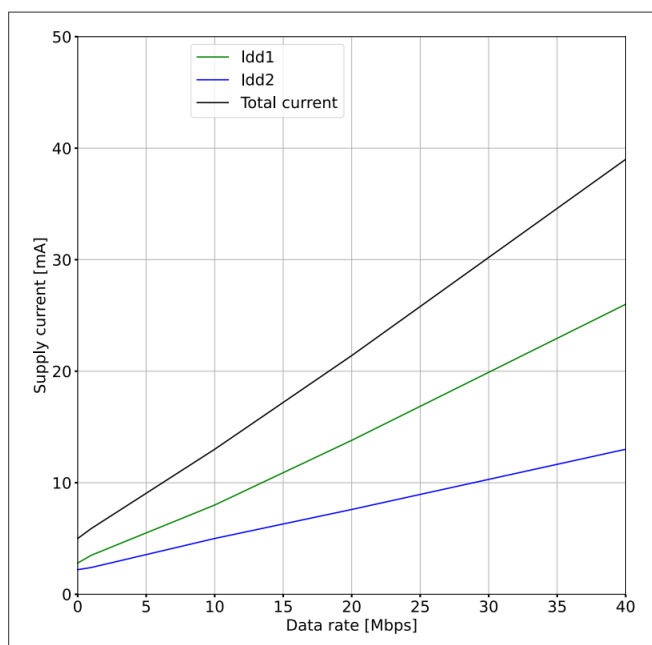


图 26 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 2.7 \text{ V}$)

3 Functional description

2+2数字隔离器 (4DIR240xHA)

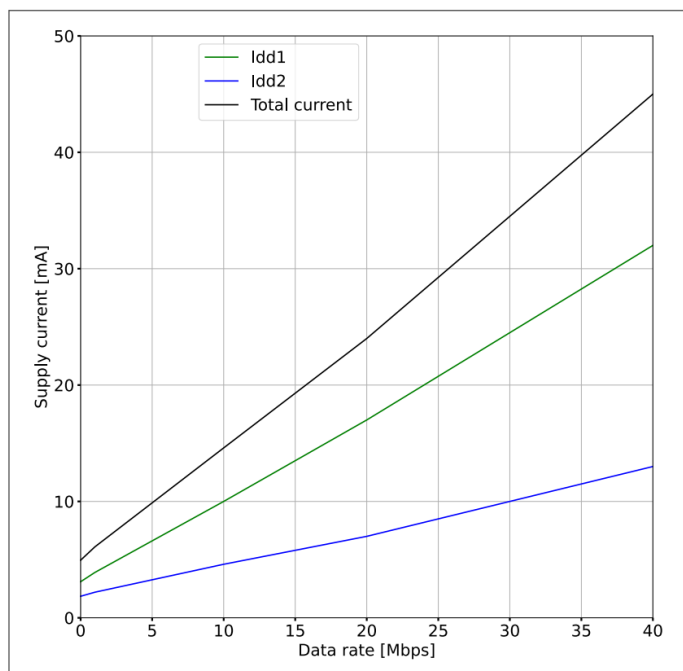


图 27 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 6.5 \text{ V}$)

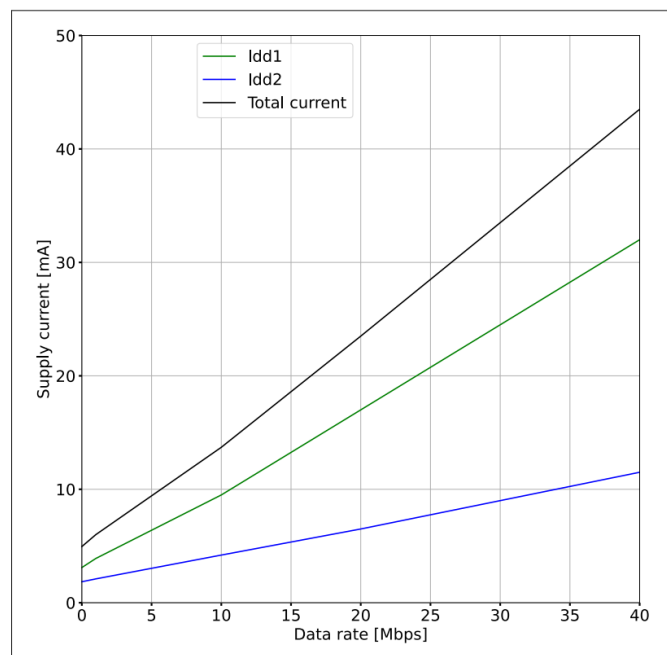


图 28 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 5 \text{ V}$)

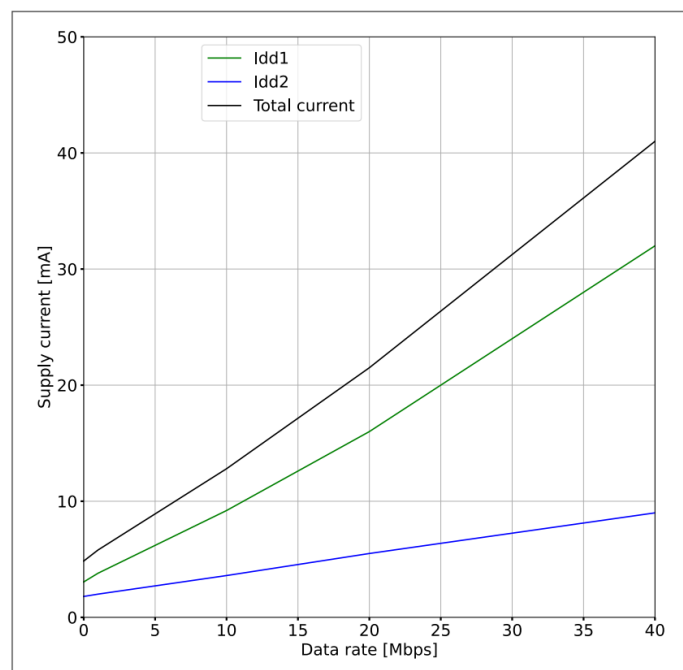


图 29 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 3.3 \text{ V}$)

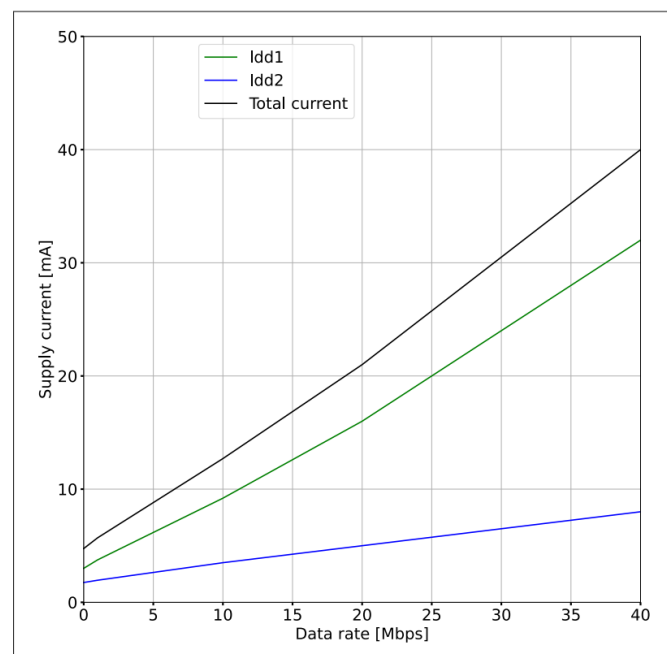


图 30 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 2.7 \text{ V}$)

3 Functional description

4+0数字隔离器 (4DIR040xHA)

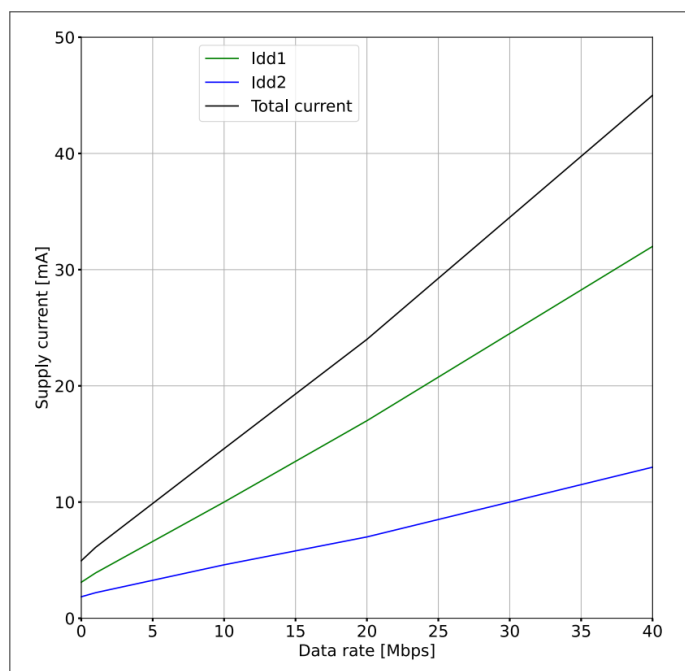


图 31 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 6.5\text{ V}$)

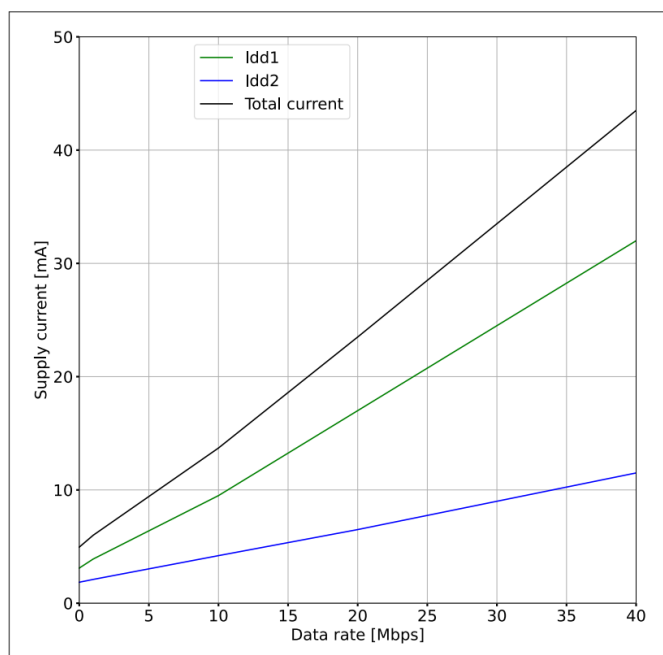


图 32 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 5\text{ V}$)

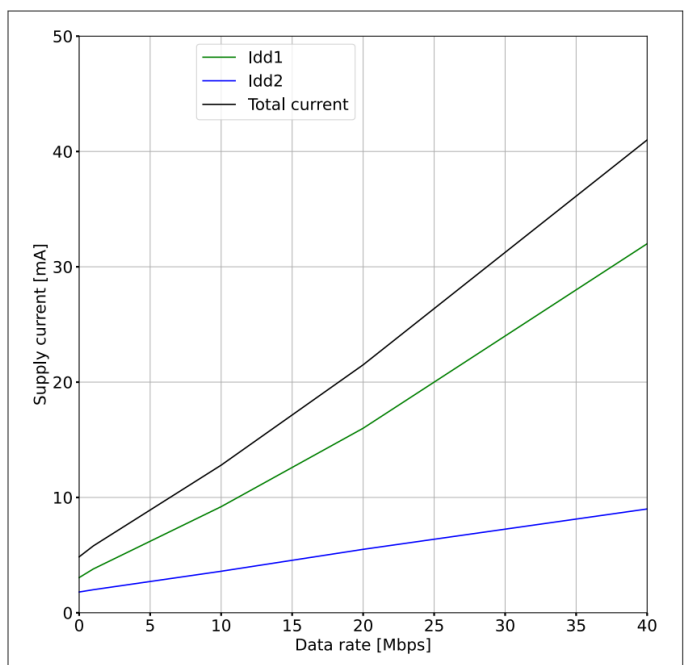


图 33 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 3.3\text{ V}$)

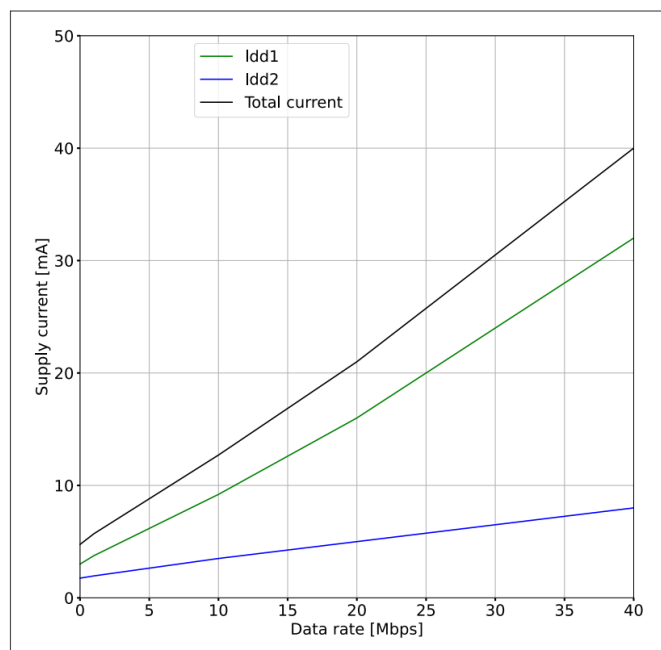


图 34 电源电流与数据速率的关系 ($V_{DD1} = V_{DD2} = 2.7\text{ V}$)

4 Thermal and electrical characteristics

4 热特性和电特性

4.1 绝对最大额定值

表7 绝对最大额定值

超过此处所列的应力可能会对器件造成永久性损坏。长时间在绝对最大额定值条件下工作可能会影响器件的可靠性。最大额定值是绝对额定值；超过其中任何一个值都可能对集成电路造成不可逆转的损坏。这些值在生产测试期间没有经过测试。

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD1}, V_{DD2}	-0.5		7.5	V	
Voltage at pins INx	V_{INX}			$V_{DD1} + 0.5$	V	1)
Voltage at pins OUTx	V_{OUTX}			$V_{DDO} + 0.5$	V	1)
Average output current per pin	I_{OUT}	-10		+10	mA	
Junction temperature	T_J	-40		150	°C	
Storage temperature	T_{STG}	-65		150	°C	
Soldering temperature	T_{SOL}			260	°C	reflow soldering according to JEDEC-J-STD-020
Electrostatic discharge HBM	V_{ESD_HBM}	-2		2	kV	Human Body Model (HBM) according to AEC-Q100-002
Electrostatic discharge CDM	V_{ESD_CDM}	-1.75		1.75	kV	Charged Device Model (CDM) according to AEC-Q100-011 Rev. D
Latch-up capability	I_{LU}			150	mA	Latch-up immunity characterization according to JEDEC78E Class II, pin voltages according to abs. max. ratings

1) V_{DD1} 和 V_{DDO} 分别指给定通道输入侧和输出侧的电源电压

4.2 额外的 ESD 额定值

表8 额外的ESD 额定值

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Contact discharge per IEC 61000-4-2	$ V_{ESD_IEC} $		22		kV	Isolation barrier withstand test ^{1) 2)}

1) IEC ESD 冲击施加于栅上，两侧的所有引脚连接在一起，形成一个双端子设备。

2) 测试在空气或油中进行，以确定设备固有的接触放电能力。

4 Thermal and electrical characteristics

4.3 工作范围

表 9 工作范围

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Data rate	DR	0		40	Mbps	
Supply voltage	V_{DD1}, V_{DD2}	2.7		6.5	V	
High-level input voltage	V_{IH}	$0.7 V_{DD1}$		V_{DD1}	V	1)
Low-level input voltage	V_{IL}	0		$0.3 V_{DD1}$	V	1)
Ambient temperature	T_A	-40		125	°C	

1) V_{DD1} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4.4 共模瞬态抗扰度 (CMTI)

表 10 共模瞬态抗扰度 (CMTI)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Static Common Mode Transient Immunity (CMTI)	$ CM_H $	100			kV/μs	$V_{CM} = 1200$ V; V_{INX} tied to V_{DD1} 1) 2) 3)
Static Common Mode Transient Immunity (CMTI)	$ CM_L $	100			kV/μs	$V_{CM} = 1200$ V; V_{INX} tied to GNDX 2) 3)

1) V_{DD1} 是指给定通道输入侧的电源电压

2) 输出信号受到干扰的共模电压的最小转换速率

3) 未在生产中测试的参数

4 Thermal and electrical characteristics

4.5 热特性

$T_A = 25^\circ\text{C}$ 时的典型热特性

表 11 JEDEC 和参考 PCB 的热特性

Parameter	Symbol	JEDEC	Reference PCB	Unit	Note or condition
Thermal resistance junction-to-ambient	R_{thJA}	60 ¹⁾	59 ²⁾	K/W	JEDEC 2s2p (JED51-7), $P_{dis} = 378$ mW
Thermal resistance junction-to-case (top)	R_{thJC}	27	27	K/W	³⁾
Thermal resistance junction-to-board	R_{thJB}	20	30	K/W	⁴⁾
Characterization parameter junction-to-top	Ψ_{thJT}	3.4	3	K/W	⁵⁾
Characterization parameter junction-to-board	Ψ_{thJB}	20	20	K/W	⁵⁾

1) 通过在 JESD51-2a 描述的环境中模拟 JEDEC 标准高 K 板（如 JESD51-7 中所述）获得

2) 通过模拟符合 JEDEC 标准的高 K 电路板（如 JESD51-7 和下面的参考 PCB 规范中所述）获得，在 JESD51-2a 描述的环境中

3) 通过模拟封装顶部的冷板测试获得。没有特定的 JEDEC 标准测试，但可以在 ANSI SEMI 标准 G30-88 中找到接近的描述

4) 通过在具有环形冷板夹具的环境中模拟来控制 PCB 温度获得，如 JESD51-8 中所述

5) 估算设备在实际系统中的结温，该温度从仿真数据中提取，用于获取热阻 R_{th} ，采用 JESD51-2a 标准（第6和第7章节）中描述的程序实现

表 12 参考 PCB 规格

Parameter	Value	λ_{therm} [W/(m-K)]
Dimension [mm ³]	76.2 x 114.3 x 1.5 (JEDEC)	
Material	FR4	0.3
Metalization	JEDEC 2s2p (JESD 51-7)	388
Cooling area	Ground inner layer	
Thermal vias	$\varnothing = 0.5\text{mm}$; plating 25 μm ; 4 x 2 pcs. connected to ground inner layer	
Package attach [50 μm]	Solder	55
Ground inner layer [mm ³]	74.2 x 74.2 x 0.03 (JEDEC), planes are 8.2 mm spaced	

4 Thermal and electrical characteristics

表 13 参考 PCB 布局

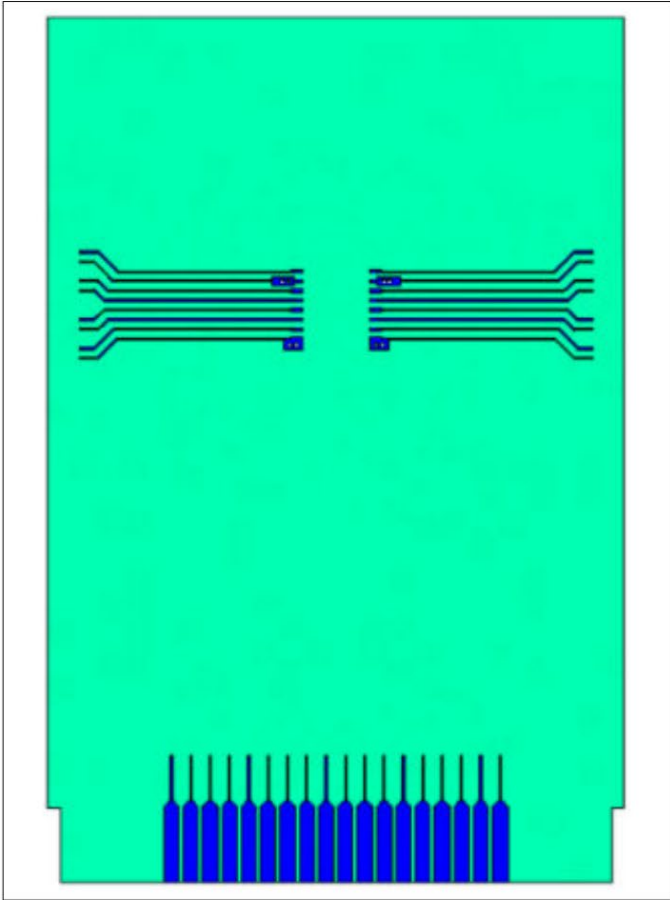


Figure 35 Top footprint

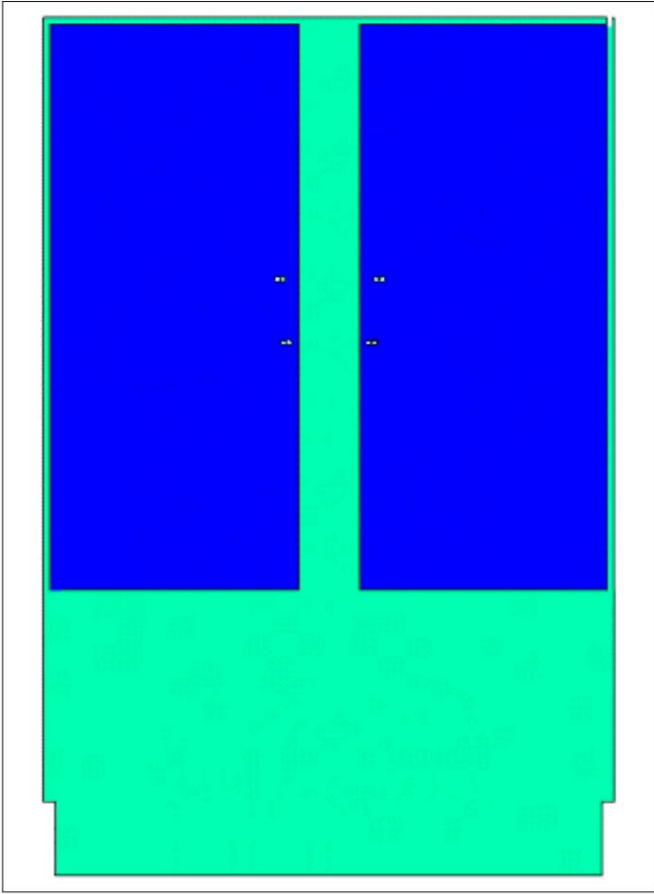


Figure 36 Inner layers (connect to ground)

4.6 电源 - UVLO

表 14 电源 - UVLO

除非另有说明，典型值是在 $T_A = 25\text{ }^{\circ}\text{C}$ 的工作范围内给出的。

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply UVLO turn-on threshold	$V_{DDX(UVLOon)}$	2.42	2.55	2.68	V	
Supply UVLO turn-off threshold	$V_{DDX(UVLOoff)}$	2.35	2.45	2.55	V	
Supply UVLO hysteresis	$V_{DDX(UVLOhys)}$	0.07	0.10		V	

4 Thermal and electrical characteristics

4.7 电气特性

电气特性涉及在规定工作条件下给出的值的分布。

4.7.1 电气特性 - 6.5V 供电

典型值是在 $T_A = 25^\circ\text{C}$ 和 $V_{DD1} = V_{DD2} = 6.5\text{ V}$ 条件下给出的。除非另有说明，否则最小/最大规格适用于整个建议工作范围 $V_{DD1} = V_{DD2} = 6.5\text{ V}$ 和 $-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ 。

除非另有说明，开关特性均在工作范围内以 $C_{LOAD} = 15\text{ pF}$ 和 50% 占空比输入方波进行测试。电源电流值基于所有通道均以相同数据速率切换的情况而指定。除非另有说明，否则参数未在生产中测试。

4.7.1.1 逻辑输入

表 15 逻辑输入

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
High-level input current	I_{IH}			10	μA	$V_{INX} = V_{DDI}$ ^{1) 2)}
Low-level input current	I_{IL}	-10			μA	$V_{INX} = 0\text{ V}$ ²⁾
Input voltage threshold for transition LH	V_{I_LH}			$0.7 V_{DDI}$	V	
Input voltage threshold for transition HL	V_{I_HL}	$0.3 V_{DDI}$			V	
Input voltage threshold hysteresis	V_{I_HYS}	$0.1 V_{DDI}$			V	
Input pull-down resistor	R_{IN}		825		k Ω	$V_{INX} = V_{DDI}$ ¹⁾

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

2) 生产中测试的参数

4.7.1.2 逻辑输出

表 16 逻辑输出

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
High-level output voltage	V_{OH}	$V_{DDO} - 0.4$			V	$I_{OH} = 4\text{ mA}$ ¹⁾
Low-level output voltage	V_{OL}			0.4	V	$I_{OL} = -4\text{ mA}$

1) V_{DDO} - 输出侧电源电压。对于 1 侧的输出缓冲器，该电压为 V_{DD1} ；对于 2 侧的输出缓冲器，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.1.3 电源 - 4DIR040xHA (4+0)

表 17 电源 - 4DIR040xHA (4+0)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			3.1	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			1.85	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			3.1	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			1.85	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.9	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2.2	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			10	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			4.6	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			17	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			7	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			32	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			13	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.1.4 电源 - 4DIR140xHA (3+1)

表 18 电源 - 4DIR140xHA (3+1)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.9	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.3	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.9	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.3	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.6	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2.6	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			8.4	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			6	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			15	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			10	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			27	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			16	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.1.5 电源 - 4DIR240xHA (2+2)

表 19 电源 - 4DIR240xHA (2+2)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.7	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.7	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.7	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.7	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.4	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			3.4	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			7.5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			7.0	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			13	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			12	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			23	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			21	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} - 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.1.6 电源 - 4DIR142xHA (3+1 EN1 neg.)

表 20 电源 - 4DIR142xHA (3+1 EN1 neg.)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.9	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.3	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.9	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.3	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.6	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2.6	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			8.4	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			6	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			15	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			10	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			27	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			16	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.1.7 动态特性

表 21 动态特性

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
INx to OUTx turn-on propagation delay	t_{PDon}	21	26	33	ns	From 50% level of rising input to 50% level of corresponding rising output ¹⁾
INx to OUTx turn-off propagation delay	t_{PDoff}	21	26	33	ns	From 50% level of rising input to 50% level of corresponding rising output ¹⁾
Part-to-part propagation delays mismatch	$\Delta t_{PD,p-p}$			6	ns	^{1) 2)}
Co-directional channel-to-channel propagation delay mismatch	$\Delta t_{PD,Ch-Ch}$			3.5	ns	Within same sample, over operating temperature range, same direction channels, switching in the same direction ¹⁾
Opposing directional channel-to-channel propagation delay mismatch	$\Delta t_{PD,Ch-Ch}$			3.5	ns	Within same sample, over operating temperature range, opposing directional channels, switching with the same signal level ¹⁾
Pulse width distortion	PWD			3	ns	$ t_{PDoff} - t_{PDon} $ ^{1) 3)}
Input pulse width that changes output state	$t_{pw,min}$	8	12.5	16	ns	Measured with full range of input signal $V_{IN} = V_{DDI}$ ⁴⁾
Output signal rise time	t_{rise}			4	ns	10% to 90% rising output, $C_{LOAD} = 15$ pF
Output signal fall time	t_{fall}			4	ns	90% to 10% falling output, $C_{LOAD} = 15$ pF
Output disable propagation delay (high output to high-impedance)	$t_{PD,HZ}$			10	ns	From 50% falling enable (except 4DIR142xHA) to $V_{OH} - 0.5$ V From 50% rising enable (for 4DIR142xHA) to $V_{OH} - 0.5$ V
Output disable propagation delay (low output to high impedance)	$t_{PD,LZ}$			10	ns	From 50% of falling enable (except 4DIR142xHA) to $V_{OL} + 0.5$ V From 50% of rising enable (for 4DIR142xHA) to $V_{OL} + 0.5$ V
Output enable propagation delay (high-impedance to high output)	$t_{PD,ZH}$			15	ns	From 50% rising enable (except 4DIR142xHA) to 50% of rising V_{OH} From 50% falling enable (for 4DIR142xHA) to 50% of rising V_{OH}

(表格续下页.....)

4 Thermal and electrical characteristics

表 21 (续) 动态特性

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Output enable propagation delay (high-impedance to low output)	$t_{PD,ZL}$			14	ns	From 50% rising enable (except 4DIR142xHA) to 50% of falling V_{OH} From 50% falling enable (for 4DIR142xHA) to 50% of falling V_{OH}
Default output delay time from input power loss	t_{DO}		0.4	2.6	μs	Measured from $V_{DDIUVLOoff} = 2.55 V$. Power supply ramp rate = 1 V/ μs
Time from UVLO to valid output data	t_{PU}			3	μs	Power supply ramp rate = 1 V/ μs , DR > 6.6 Mbps

- 1) 生产中测试的参数
- 2) 该参数给出了在相同条件下（包括相同的环境温度）沿相同方向切换的不同样本之间的传播延迟差异
- 3) 也称为脉冲偏差。该参数给出了同一样品在工作温度范围内显示的开启和关闭传播延迟之间的最大差异
- 4) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.2 电气特性 - 5 V 电源

典型值基于 $T_A = 25^\circ\text{C}$ 、 $V_{DD1} = V_{DD2} = 5\text{V}$ 的条件。除非另有说明，最小/最大规格适用于整个建议工作范围：

$V_{DD1} = V_{DD2} = 5\text{V} \pm 10\%$ 和 $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ 。

除非另有说明，否则开关特性均在工作范围内以 $C_{\text{LOAD}} = 15\text{ pF}$ 和 50% 占空比输入方波进行测试。电源电流值的计算考虑了所有通道均以相同的数据速率切换。除非另有说明，否则参数均在生产过程中进行测试。生产过程中仅测试直流电源电流，不测试交流电源电流。

4.7.2.1 逻辑输入

表 22 逻辑输入

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
High-level input current	I_{IH}			10	μA	$V_{\text{INX}} = V_{\text{DDI}}$ ^{1) 2)}
Low-level input current	I_{IL}	-10			μA	$V_{\text{INX}} = 0\text{ V}$ ²⁾
Input voltage threshold for transition LH	V_{I_LH}			$0.7V_{\text{D DI}}$	V	
Input voltage threshold for transition HL	V_{I_HL}	$0.3V_{\text{D DI}}$			V	
Input voltage threshold hysteresis	V_{I_HYS}	$0.1 V_{\text{D DI}}$			V	
Input pull-down resistor	R_{IN}		825		k Ω	$V_{\text{INX}} = V_{\text{DDI}}$ ¹⁾

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

2) 参数未在生产中测试

4.7.2.2 逻辑输出

表 23 逻辑输出

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
High-level output voltage	V_{OH}	$V_{\text{DDO}} - 0.4$			V	$I_{\text{OH}} = 4\text{ mA}$ ¹⁾
Low-level output voltage	V_{OL}			0.4	V	$I_{\text{OL}} = -4\text{ mA}$

1) V_{DDO} - 输出侧电源电压。对于 1 侧的输出缓冲器，该电压为 V_{DD1} ；对于 2 侧的输出缓冲器，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.2.3 电源 - 4DIR040xHA (4+0)

表 24 电源 - 4DIR040xHA (4+0)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			3.1	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			1.85	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			3.1	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			1.85	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.9	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2.1	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			9.5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			4.2	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			17	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			6.5	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			32	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			11.5	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.2.4 电源 - 4DIR140xHA (3+1)

表 25 电源 - 4DIR140xHA (3+1)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.9	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.3	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.9	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.3	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.6	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2.5	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			8.3	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			5.5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			14.5	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			9.5	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			27	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			16	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.2.5 电源 - 4DIR240xHA (2+2)

表 26 电源 - 4DIR240xHA (2+2)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.65	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.65	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.65	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.65	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.3	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			3.3	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			7.5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			7	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			13	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			12	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			23	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			21	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.2.6 电源 - 4DIR142xHA (3+1 EN1 neg.)

表 27 电源 - 4DIR142xHA (3+1 EN1 neg.)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.9	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.3	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.9	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.3	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.6	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2.5	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			8.3	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			5.5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			14.5	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			9.5	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			27	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			16	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.2.7 动态特性

表 28 动态特性

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
INx to OUTx turn-on propagation delay	t_{PDOn}	21	26	32	ns	From 50% level of rising input to 50% level of corresponding rising output
INx to OUTx turn-off propagation delay	t_{PDOff}	21	26	32	ns	From 50% level of falling input to 50% level of corresponding falling output
Part-to-part propagation delays mismatch	$\Delta t_{PD,p-p}$			6	ns	¹⁾
Co-directional channel-to-channel propagation delay mismatch	$\Delta t_{PD,Ch-Ch}$			3	ns	Within same sample, over operating temperature range, same direction channels, switching in the same direction
Opposing directional channel-to-channel propagation delay mismatch	$\Delta t_{PD,Ch-Ch}$			3	ns	Within same sample, over operating temperature range, opposing directional channels, switching with the same signal level
Pulse width distortion	PWD			3	ns	$ t_{PDOff} - t_{PDOn} $ ²⁾
Input pulse width that changes output state	$t_{pw,min}$	8.5	12.5	15	ns	Measured with full range of input signal $V_{IN} = V_{DDI}$ ³⁾
Output signal rise time	t_{rise}			3.5	ns	10% to 90% rising output, $C_{LOAD} = 15 \text{ pF}$ ⁴⁾
Output signal fall time	t_{fall}			3.5	ns	90% to 10% falling output, $C_{LOAD} = 15 \text{ pF}$ ⁴⁾
Output disable propagation delay (high output to high-impedance)	$t_{PD,HZ}$			11	ns	From 50% falling enable (except 4DIR142xHA) to $V_{OH} - 0.5 \text{ V}$ From 50% rising enable (for 4DIR142xHA) to $V_{OH} - 0.5 \text{ V}$ ⁴⁾
Output disable propagation delay (low output to high-impedance)	$t_{PD,LZ}$			10	ns	From 50% of falling enable (except 4DIR142xHA) to $V_{OL} + 0.5 \text{ V}$ From 50% of rising enable (for 4DIR142xHA) to $V_{OL} + 0.5 \text{ V}$ ⁴⁾
Output enable propagation delay (high-impedance to high output)	$t_{PD,ZH}$			14	ns	From 50% rising enable (except 4DIR142xHA) to 50% of rising V_{OH} From 50% falling enable (for 4DIR142xHA) to 50% of rising V_{OH} ⁴⁾

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4 Thermal and electrical characteristics

表 28 (续) 动态特性

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Output enable propagation delay (high-impedance to low output)	$t_{PD,ZL}$			13	ns	From 50% of rising enable (except 4DIR142xHA) to 50% of falling V_{OH} From 50% of falling enable (for 4DIR142xHA) to 50% of falling V_{OH} ⁴⁾
Default output delay time from input power loss	t_{DO}		0.4	2.6	μs	Measured from $V_{DDIUVOFF} = 2.55$ V. Power supply ramp rate = 1 V/ μs
Time from UVLO to valid output data	t_{PU}			3	μs	Power supply ramp rate = 1 V/ μs , DR > 6.6 Mbps ⁴⁾

- 1) 该参数给出了在相同条件下（包括相同的环境温度）沿相同方向切换的不同样本之间的传播延迟差异
- 2) 也称为脉冲偏差。该参数给出了同一样品在工作温度范围内显示的开启和关闭传播延迟之间的最大差异
- 3) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。
- 4) 参数未在生产中测试

4 Thermal and electrical characteristics

4.7.3 电气特性 - 3.3 V 电源

典型值基于 $T_A = 25^\circ\text{C}$ 、 $V_{DD1} = V_{DD2} = 3.3\text{V}$ 的条件。除非另有说明，最小/最大规格适用于整个建议工作范围：

$V_{DD1} = V_{DD2} = 3.3\text{V} \pm 10\%$ 和 $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ 。

除非另有说明，否则开关特性均在工作范围内以 $C_{\text{LOAD}} = 15\text{ pF}$ 和 50% 占空比输入方波进行测试。电源电流值的计算考虑了所有通道均以相同的数据速率切换。除非另有说明，否则参数均在生产过程中进行测试。生产过程中仅测试直流电源电流，不测试交流电源电流。

4.7.3.1 逻辑输入

表 29 逻辑输入

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
High-level input current	I_{IH}			10	μA	$V_{\text{INX}} = V_{\text{DDI}}$ ^{1) 2)}
Low-level input current	I_{IL}	-10			μA	$V_{\text{INX}} = 0\text{ V}$ ²⁾
Input voltage threshold for transition LH	V_{I_LH}			$0.7V_{D_DI}$	V	
Input voltage threshold for transition HL	V_{I_HL}	$0.3V_{D_DI}$			V	
Input voltage threshold hysteresis	V_{I_HYS}	$0.1 V_{D_DI}$			V	
Input pull-down resistor	R_{IN}		825		k Ω	$V_{\text{INX}} = V_{\text{DDI}}$ ^{1) 2)}

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

2) 参数未在生产中测试

4.7.3.2 逻辑输出

表 30 逻辑输出

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
High-level output voltage	V_{OH}	$V_{DDO} - 0.3$			V	$I_{OH} = 2\text{ mA}$ ¹⁾
Low-level output voltage	V_{OL}			0.3	V	$I_{OL} = -2\text{ mA}$

1) V_{DDO} - 输出侧电源电压。对于 1 侧的输出缓冲器，该电压为 V_{DD1} ；对于 2 侧的输出缓冲器，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.3.3 电源 - 4DIR040xHA (4+0)

表 31 电源 - 4DIR040xHA (4+0)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			3.05	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			1.8	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			3.05	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			1.8	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.8	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			9.2	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			3.6	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			16	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			5.5	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			32	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			9	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} - 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.3.4 电源 - 4DIR140xHA (3+1)

表 32 电源 - 4DIR140xHA (3+1)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.85	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.25	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.85	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.25	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.5	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2.4	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			8.1	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			14	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			8	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			26	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			14	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} - 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.3.5 电源 - 4DIR240xHA (2+2)

表 33 电源 - 4DIR240xHA (2+2)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.6	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.6	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.6	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.6	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.2	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			3.2	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			7	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			6.5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			12	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			11	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			21	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			19	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} - 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.3.6 电源 - 4DIR142xHA (3+1 EN1 neg.)

表 34 电源 - 4DIR142xHA (3+1 EN1 neg.)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.85	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.25	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.85	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.25	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.5	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2.4	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			8.1	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			14	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			8	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			26	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			14	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} - 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.3.7 动态特性

表 35 动态特性

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
INx to OUTx turn-on propagation delay	t_{PDOn}	21	26	32	ns	From 50% level of rising input to 50% level of rising output
INx to OUTx turn-off propagation delay	t_{PDOff}	21	26	32	ns	From 50% level of falling input to 50% level of falling output
Part-to-part propagation delays mismatch	$\Delta t_{PD,p-p}$			6	ns	¹⁾
Co-directional channel-to-channel propagation delay mismatch	$\Delta t_{PD,Ch-Ch}$			3	ns	Within same sample, over operating temperature range, same direction channels, switching in the same direction
Opposing directional channel-to-channel propagation delay mismatch	$\Delta t_{PD,Ch-Ch}$			3	ns	Within same sample, over operating temperature range, opposing directional channels, switching with the same signal level.
Pulse width distortion	PWD			3	ns	$ t_{PDOff} - t_{PDOn} $ ²⁾
Input pulse width that changes output state	$t_{pw,min}$	9	12.5	15	ns	Measured with full range of input signal $V_{IN} = V_{DDI}$ ³⁾
Output signal rise time	t_{rise}			3.5	ns	10% to 90% rising output, $C_{LOAD} = 15 \text{ pF}$ ⁴⁾
Output signal fall time	t_{fall}			3.5	ns	90% to 10% falling output, $C_{LOAD} = 15 \text{ pF}$ ⁴⁾
Output disable propagation delay (high output to high-impedance)	$t_{PD,HZ}$			13	ns	From 50% falling enable (except 4DIR142xHA) to $V_{OH} - 0.5 \text{ V}$ From 50% rising enable (for 4DIR142xHA) to $V_{OH} - 0.5 \text{ V}$ ⁴⁾
Output disable propagation delay (low output to high-impedance)	$t_{PD,LZ}$			12	ns	From 50% of falling enable (except 4DIR142xHA) to $V_{OL} + 0.5 \text{ V}$ From 50% of rising enable (for 4DIR142xHA) to $V_{OL} + 0.5 \text{ V}$ ⁴⁾
Output enable propagation delay (high-impedance to high output)	$t_{PD,ZH}$			14	ns	From 50% rising enable (except 4DIR142xHA) to 50% of rising V_{OH} From 50% falling enable (for 4DIR142xHA) to 50% of rising V_{OH} ⁴⁾

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4 Thermal and electrical characteristics

表 35 (续) 动态特性

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Output enable propagation delay (high-impedance to low output)	$t_{PD,ZL}$			13	ns	From 50% of rising enable (except 4DIR142xHA) to 50% of falling V_{OH} From 50% of falling enable (for 4DIR142xHA) to 50% of falling V_{OH} ⁴⁾
Default output delay time from input power loss	t_{DO}		0.4	2.6	μs	Measured from $V_{DDIUVLOff} = 2.55$ V. Power supply ramp rate = 1 V/ μs
Time from UVLO to valid output data	t_{PU}			3	μs	Power supply ramp rate = 1 V/ μs, DR > 6.6 Mbps ⁴⁾

- 1) 该参数给出了在相同条件下（包括相同的环境温度）沿相同方向切换的不同样本之间的传播延迟差异
- 2) 也称为脉冲偏差。该参数给出了同一样品在工作温度范围内显示的开启和关闭传播延迟之间的最大差异
- 3) V_{DDI} - 输入侧电源电压。对于 1 侧的输入通道，该电压为 V_{DD1} ；对于 2 侧的输入通道，该电压为 V_{DD2} 。
- 4) 参数未在生产中测试

4 Thermal and electrical characteristics

4.7.4 电气特性 - 2.7V 供电

典型值是在 $T_A = 25^\circ\text{C}$ 和 $V_{DD1} = V_{DD2} = 2.7\text{V}$ 条件下给出的。除非另有说明，否则最小/最大规格适用于整个建议工作范围 $V_{DD1} = V_{DD2} = 2.7\text{V}$ 和 $-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ 。

除非另有说明，开关特性均在工作范围内以 $C_{LOAD} = 15\text{pF}$ 和 50% 占空比输入方波进行测试。电源电流值基于所有通道均以相同数据速率切换的情况而指定。除非另有说明，否则参数未在生产中测试。

4.7.4.1 逻辑输入

表 36 逻辑输入

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
High-level input current	I_{IH}			10	μA	$V_{INX} = V_{DD1}$ ¹⁾
Low-level input current	I_{IL}	-10			μA	$V_{INX} = 0\text{V}$
Input voltage threshold for transition LH	V_{I_LH}			$0.7 V_{DD1}$	V	
Input voltage threshold for transition HL	V_{I_HL}	$0.3 V_{DD1}$			V	
Input voltage threshold hysteresis	V_{I_HYS}	$0.1 V_{DD1}$			V	
Input pull-down resistor	R_{IN}		825		$\text{k}\Omega$	$V_{INX} = V_{DD1}$ ¹⁾

1) V_{DD1} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4.7.4.2 逻辑输出

表 37 逻辑输出

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
High-level output voltage	V_{OH}	$V_{DDO} - 0.3$			V	$I_{OH} = 1\text{mA}$ ¹⁾
Low-level output voltage	V_{OL}			0.3	V	$I_{OL} = -1\text{mA}$

1) V_{DDO} - 输出侧电源电压。对于 1 侧的输出缓冲器，该电压为 V_{DD1} ；对于 2 侧的输出缓冲器，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.4.3 电源 - 4DIR040xHA (4+0)

表 38 电源 - 4DIR040xHA (4+0)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			3	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			1.75	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			3	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			1.75	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.75	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			1.95	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			9.2	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			3.5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			16	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			5	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			32	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			8	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.4.4 电源 - 4DIR140xHA (3+1)

表 39 电源 - 4DIR140xHA (3+1)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.8	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.2	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.8	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.2	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.5	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2.4	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			8	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			13.8	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			7.6	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			26	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			13	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.4.5 电源 - 4DIR240xHA (2+2)

表 40 电源 - 4DIR240xHA (2+2)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.6	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.6	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.6	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.6	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.2	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			3.2	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			7	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			6.5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			12	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			11	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			21	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			19	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.4.6 电源 - 4DIR142xHA (3+1 EN1 neg.)

表 41 电源 - 4DIR142xHA (3+1 EN1 neg.)

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply current - DC input	I_{DD1}			2.8	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD2}			2.2	mA	$V_{INx} = V_{DDI}$ ¹⁾
Supply current - DC input	I_{DD1}			2.8	mA	$V_{INx} = 0\text{ V}$
Supply current - DC input	I_{DD2}			2.2	mA	$V_{INx} = 0\text{ V}$
Supply current - AC input	I_{DD1_1Mb}			3.5	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD2_1Mb}			2.4	mA	$DR = 1\text{ Mbps}$
Supply current - AC input	I_{DD1_10Mb}			8	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD2_10Mb}			5	mA	$DR = 10\text{ Mbps}$
Supply current - AC input	I_{DD1_20Mb}			13.8	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD2_20Mb}			7.6	mA	$DR = 20\text{ Mbps}$
Supply current - AC input	I_{DD1_40Mb}			26	mA	$DR = 40\text{ Mbps}$
Supply current - AC input	I_{DD2_40Mb}			13	mA	$DR = 40\text{ Mbps}$

1) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.7.4.7 动态特性

表 42 动态特性

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
INx to OUTx turn-on propagation delay	t_{PDOn}	20	26	33	ns	From 50% level of rising input to 50% level of corresponding rising output ¹⁾
INx to OUTx turn-off propagation delay	t_{PDOff}	20	26	33	ns	From 50% level of falling input to 50% level of corresponding falling output ¹⁾
Part-to-part propagation delays mismatch	$\Delta t_{PD,p-p}$			6	ns	^{1) 2)}
Co-directional channel-to-channel propagation delay mismatch	$\Delta t_{PD,Ch-Ch}$			3	ns	Within same sample, over operating temperature range, same direction channels, switching in the same direction ¹⁾
Opposing directional channel-to-channel propagation delay mismatch	$\Delta t_{PD,Ch-Ch}$			3	ns	Within same sample, over operating temperature range, opposing directional channels, switching with the same signal level ¹⁾
Pulse width distortion	PWD			3.5	ns	$ t_{PDOff} - t_{PDOn} $ ^{1) 3)}
Input pulse width that changes output state	$t_{pw,min}$	8.5	12.5	16	ns	Measured with full range of input signal $V_{IN} = V_{DDI}$ ^{1) 4)}
Output signal rise time	t_{rise}			3	ns	10% to 90% rising output, $C_{LOAD} = 15 \text{ pF}$
Output signal fall time	t_{fall}			3	ns	90% to 10% falling output, $C_{LOAD} = 15 \text{ pF}$
Output disable propagation delay (high output to high-impedance)	$t_{PD,HZ}$			13	ns	From 50% falling enable (except 4DIR142xHA) to $V_{OH} - 0.5 \text{ V}$ From 50% rising enable (for 4DIR142xHA) to $V_{OH} - 0.5 \text{ V}$
Output disable propagation delay (low output to high-impedance)	$t_{PD,LZ}$			13	ns	From 50% of falling enable (except 4DIR142xHA) to $V_{OL} + 0.5 \text{ V}$ From 50% of rising enable (for 4DIR142xHA) to $V_{OL} + 0.5 \text{ V}$
Output enable propagation delay (high-impedance to high output)	$t_{PD,ZH}$			14	ns	From 50% rising enable (except 4DIR142xHA) to 50% of rising V_{OH} From 50% falling enable (for 4DIR142xHA) to 50% of rising V_{OH}

(表格续下页.....)

4 Thermal and electrical characteristics

表 42 (续) 动态特性

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Output enable propagation delay (high-impedance to low output)	$t_{PD,ZL}$			13	ns	From 50% of rising enable (except 4DIR142xHA) to 50% of falling V_{OH} From 50% of falling enable (for 4DIR142xHA) to 50% of falling V_{OH}
Default output delay time from input power loss	t_{DO}		0.4	2.6	μs	Measured from $V_{DDIUVL0off} = 2.55$ V. Power supply ramp rate = 1 V/ μs ¹⁾
Time from UVLO to valid output data	t_{PU}			3	μs	Power supply ramp rate = 1 V/ μs , DR > 6.6 Mbps

- 1) 生产中测试的参数
- 2) 该参数给出了在相同条件下（包括相同的环境温度）沿相同方向切换的不同样本之间的传播延迟差异
- 3) 也称为脉冲偏差。该参数给出了同一样品在工作温度范围内显示的开启和关闭传播延迟之间的最大差异
- 4) V_{DDI} = 输入侧电源电压。对于 1 侧输入通道，该电压为 V_{DD1} ；对于 2 侧输入通道，该电压为 V_{DD2} 。

4 Thermal and electrical characteristics

4.8 绝缘和安全相关规格

该耦合器仅适用于安全限值内的额定绝缘。应通过适当的保护电路确保符合安全限值。

4.8.1 绝缘特性

Parameter	Symbol	Value	Unit	Note or condition
External clearance	<i>CLR</i>	>8	mm	Shortest distance in air from any input pin to any output pin according to IEC 60664-1 ¹⁾
External creepage	<i>CRP</i>	>8	mm	Shortest distance over package surface from any input pin to any output pin according to IEC 60664-1 ¹⁾
Comparative tracking index	<i>CTI</i>	≥600	V	According to IEC 60112
Material group		I		According to IEC 60112
Pollution degree		2		According to IEC 60664-1
Overvoltage category		I - IV		Rated mains voltage ≤ 150 V _{RMS} According to IEC 60664-1
Overvoltage category		I - IV		Rated mains voltage ≤ 300 V _{RMS} According to IEC 60664-1
Overvoltage category		I - III		Rated mains voltage ≤ 600 V _{RMS} According to IEC 60664-1
Overvoltage category		I-II		Rated mains voltage ≤ 1000 V _{RMS} According to IEC 60664-1
Climatic category		40/125 /21		

输入至输出隔离符合 UL1577 Ed. 5 标准

Input-to-output isolation voltage	V_{ISO}	5700	V _{rms}	$V_{TEST} = V_{ISO}$ for $t = 60$ s (qualification); $V_{TEST} = 1.2 \times V_{ISO}$ for $t = 1$ s (100% productive tests)
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输入至输出隔离符合 DIN VDE V 0884-17、IEC 60747-17 ²⁾

Maximum rated transient isolation voltage	V_{IOTM}	8000	V _{pk}	$V_{TEST} = V_{IOTM}$ for $t_{ini} = 60$ s (type test and sample test) $V_{TEST} = 1.2 \times V_{IOTM}$ for $t_{ini} = 1$ s (routine test)
Maximum Impulse voltage	V_{IMP}	8000	V _{pk}	According to IEC 60664-1, IEC 60747-17
Maximum rated repetitive peak isolation voltage	V_{IORM}	1767	V _{pk}	According to Time Dependent Dielectric Breakdown (TDDB) test

4 Thermal and electrical characteristics

Parameter	Symbol	Value	Unit	Note or condition
Apparent charge	q_{PD}	<5	pC	Method (b1) (routine test and type test pre-conditioning) $V_{PD(ini)} = 1.2 \times V_{IOTM}$ for $t_{ini} = 1$ s $V_{PD(m)} = 1.875 \times V_{IORM}$ for $t_m = 1$ s ³⁾ Method (a) (type test, subgroup 1 final measurements) $V_{PD(ini)} = V_{IOTM}$ for $t_{ini} = 60$ s $V_{PD(m)} = 1.6 \times V_{IORM}$ for $t_m = 10$ s Method (a) (type test, subgroup 2, 3 final measurements) $V_{PD(ini)} = V_{IOTM}$ for $t_{ini} = 60$ s $V_{PD(m)} = 1.2 \times V_{IORM}$ for $t_m = 10$ s
Maximum surge isolation voltage	V_{IOSM}	10400	V_{pk}	$V_{IOSM} = 10.4 \text{ kV}_{pk} \geq 1.3 \times V_{IMP}$ for reinforced isolation according to IEC 60747-17 (type test) ⁴⁾
Isolation resistance ⁶⁾	R_{IO}	$>10^{12}$	Ω	$V_{IO} = 500 \text{ V}_{dc}$ for $t = 60$ s, $T_A = 25^\circ\text{C}$ ⁵⁾
		$>10^{11}$	Ω	$V_{IO} = 500 \text{ V}_{dc}$ for $t = 60$ s, $T_A = 125^\circ\text{C}$ ⁵⁾
	R_{IO_S}	$>10^9$	Ω	$V_{IO} = 500 \text{ V}_{dc}$ for $t = 60$ s, $T_A = T_S = 150^\circ\text{C}$ ⁵⁾
Isolation capacitance ⁶⁾	C_{IO}	<2	pF	$f = 1 \text{ MHz}$ ⁵⁾

1) 爬电距离和间隙要求取决于应用和相关的终端设备隔离标准。应注意保持印刷电路板级别所需的爬电距离和间隙值。

2) 计划进行安全认证。IEC 60747-17 及其德国等效标准 VDE 0884-17 是组件标准 VDE 0884-11 的后继者，后者将于 2023 年到期。

3) 生产测试期间施加的局部放电电压 $V_{PD(m)}$ 较大 ($4411 \text{ V}_{pk} > 1.875 \times V_{IORM}$)，以包含 F_4 系数 (1.1)，该系数考虑了电源电压与其标称值的最大偏差，如终端设备标准 IEC 60664-1、IEC 62368-1 ($V_{PD(m)} = F_1 \times F_2 \times F_3 \times F_4 \times V_{IORM} = 1.875 \times F_4 \times V_{IORM}$) 所规定。对于 IEC 60664-1 中规定的增强隔离，还考虑了 F_3 系数(1.25)。

4) 浪涌测试在绝缘油中进行，以确定绝缘层的固有浪涌抗扰度。

5) 该参数适用于将该产品转换为双端子器件来测量时，即其中一侧的所有端子连接在一起，另一侧的所有端子连接在一起。

6) 参数未在生产中测试。

4 Thermal and electrical characteristics

4.8.2 安全限值

该耦合器仅适用于安全限值内的额定绝缘。应通过适当的保护电路确保符合安全限值。

Parameter	Symbol	Value	Unit	Note or condition
Maximum ambient safety temperature	T_S	150	°C	
Safety power dissipation	P_S	2.08	W	$R_{thJA} = 60 \text{ K/W}$, $T_A = 25 \text{ °C}$, $T_J = 150 \text{ °C}$
Safety supply current	$I_{S,TOT}$	416	mA	$R_{thJA} = 60 \text{ K/W}$, $T_A = 25 \text{ °C}$, $T_J = 150 \text{ °C}$, $V_{DDX} = 5.0 \text{ V}$

4.8.2.1 热降额曲线

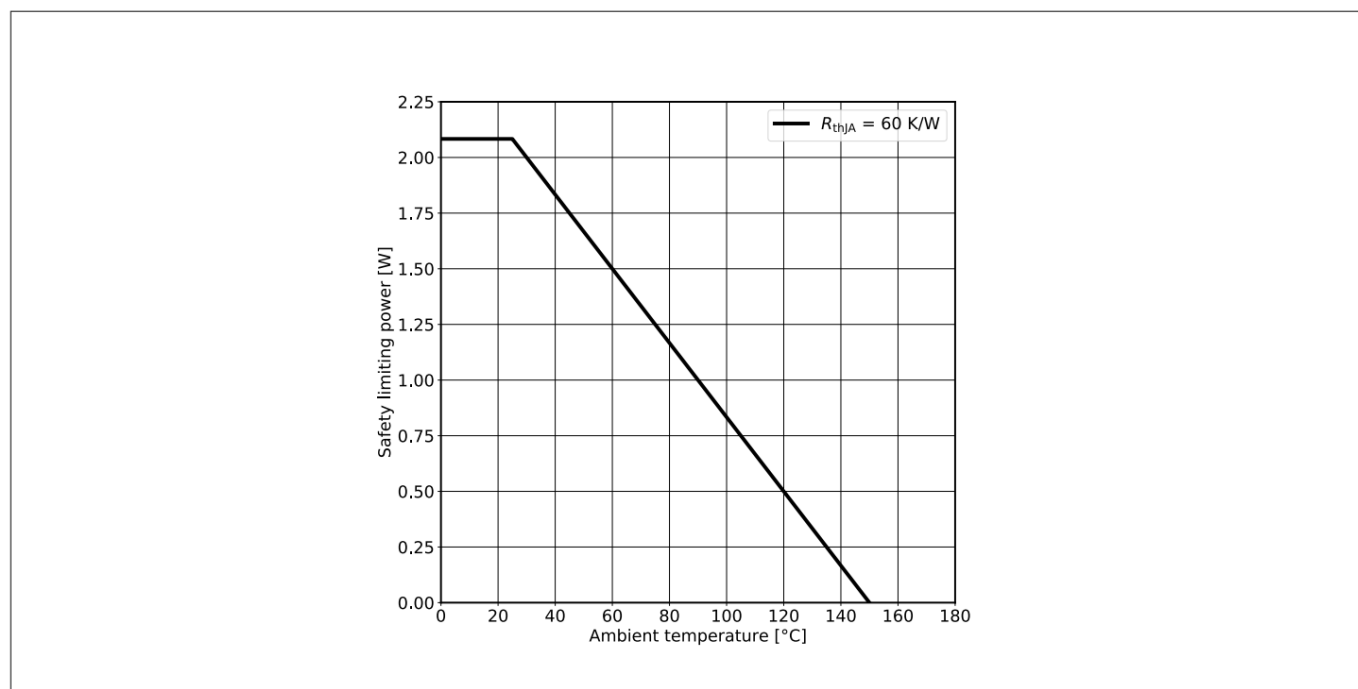


图37 热降额曲线

5 Package dimensions

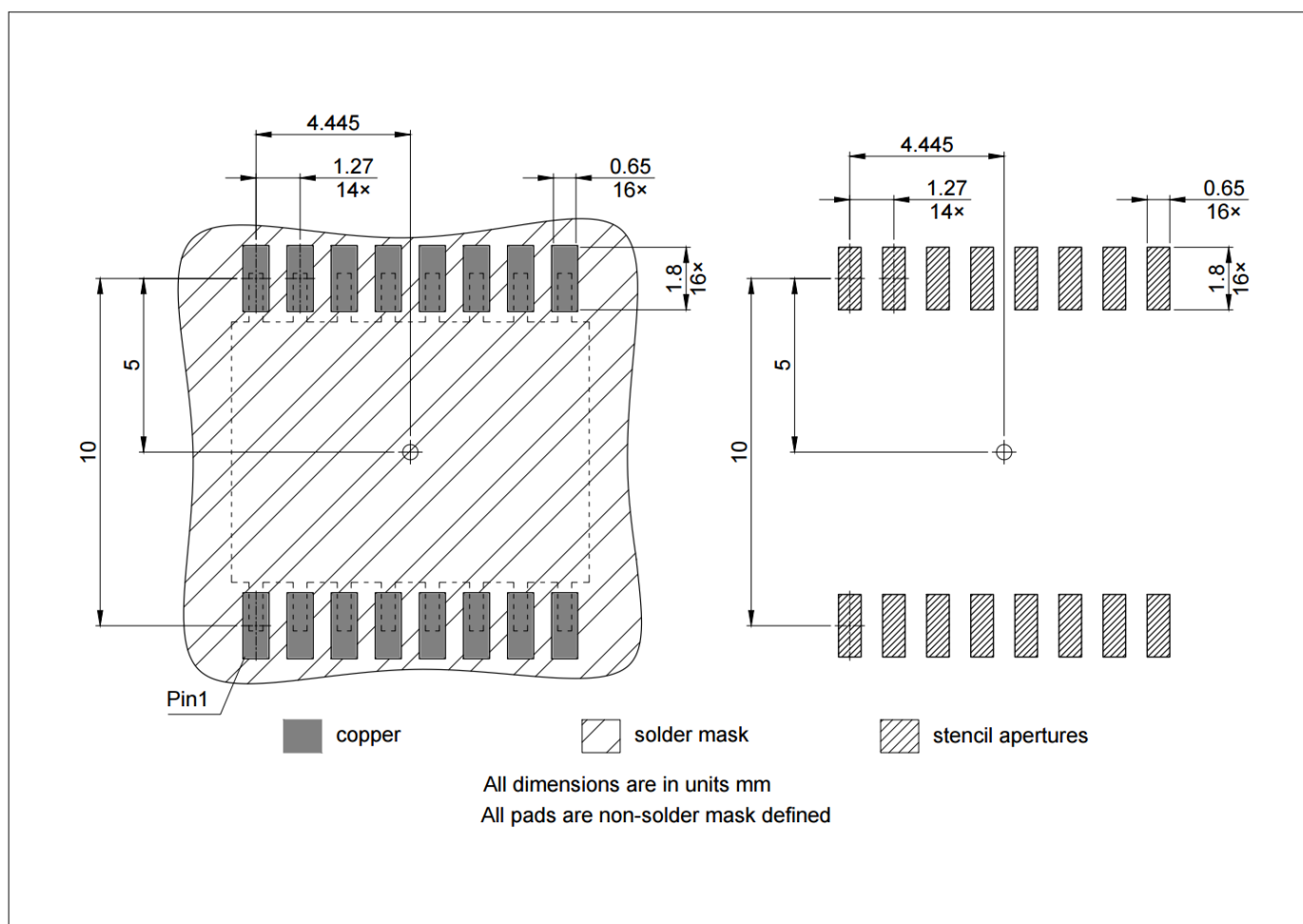


图39 PG-DSO-16 宽体 300mil 焊盘布局

5 Package dimensions

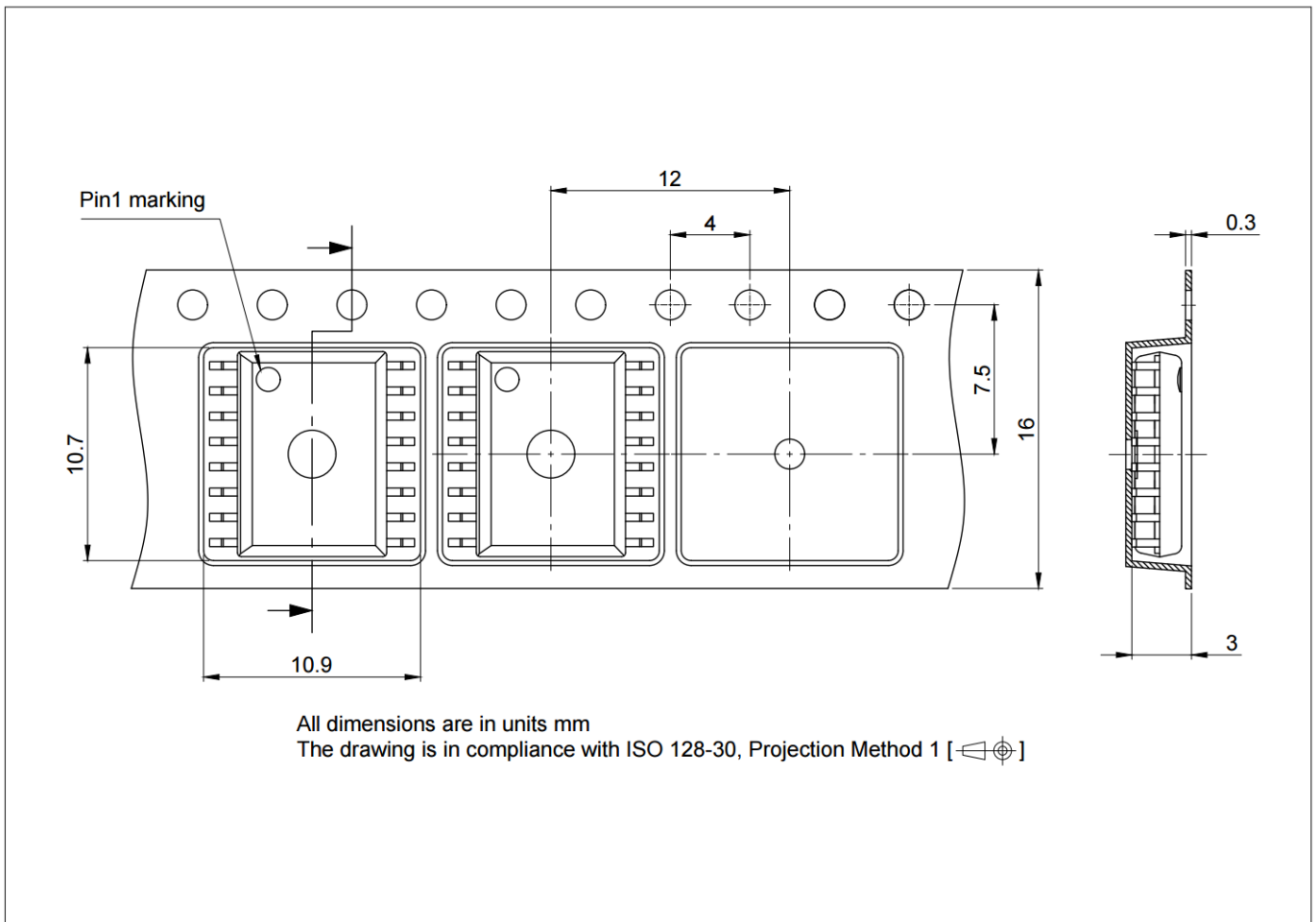


图 40 PG-DSO-16 宽体 300mil 包装

绿色产品（符合RoHS标准）

为了满足全球客户对环保产品的要求，并符合政府规定，该设备可作为绿色产品提供。绿色产品符合RoHS标准（即，引线采用无铅涂层，并且符合IPC/JEDEC J-STD-020标准，适用于无铅焊接）。

有关封装的更多信息，请访问 <https://www.infineon.com/packages>

6 Ordering guide

6 订购指南

Orderable part number (OPN)	Part number	Channel configuration	Default output state	Output enable	Package marking
4DIR0400HAXUMA1	4DIR0400HA	4 forward 0 reverse (4+0)	Low	Active-high	4R0400AA
4DIR0401HAXUMA1	4DIR0401HA		High		4R0401AA
4DIR1400HAXUMA1	4DIR1400HA	3 forward 1 reverse (3+1)	Low		4R1400AA
4DIR1401HAXUMA1	4DIR1401HA		High		4R1401AA
4DIR2400HAXUMA1	4DIR2400HA	2 forward 2 reverse (2+2)	Low		4R2400AA
4DIR2401HAXUMA1	4DIR2401HA		High		4R2401AA
4DIR1420HAXUMA1	4DIR1420HA	3 forward 1 reverse (3+1)	Low	Active-low ¹⁾	4R1420AA
4DIR1421HAXUMA1	4DIR1421HA		High		4R1421AA

1) 非常适合共享 SPI 总线

7 Revision history

7 修订记录

Revision number	Major changes since previous revision
V1.8, 2025-04-22	Removed the planed VDE reinforced isolation certification
V1.7, 2024-07-25	Updated Certification status
V1.6, 2024-04-17	Changed V_{IOSM} from 11000 V_{PK} to 10400 V_{PK}
V1.5, 2024-03-19	Changed V_{IOSM} from 10000 V_{pk} to 11000 V_{pk} and changed V_{IORM} from 1131 V_{pk} to 1767 V_{pk}
V1.3, 2023-12-05	Added 4 forward and 0 reverse (4+0) variant (4DIR040xHA) to the portfolio
V1.2, 2023-11-13	Figure 1 updated
V1.0, 2023-07-26	Datasheet initial release

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