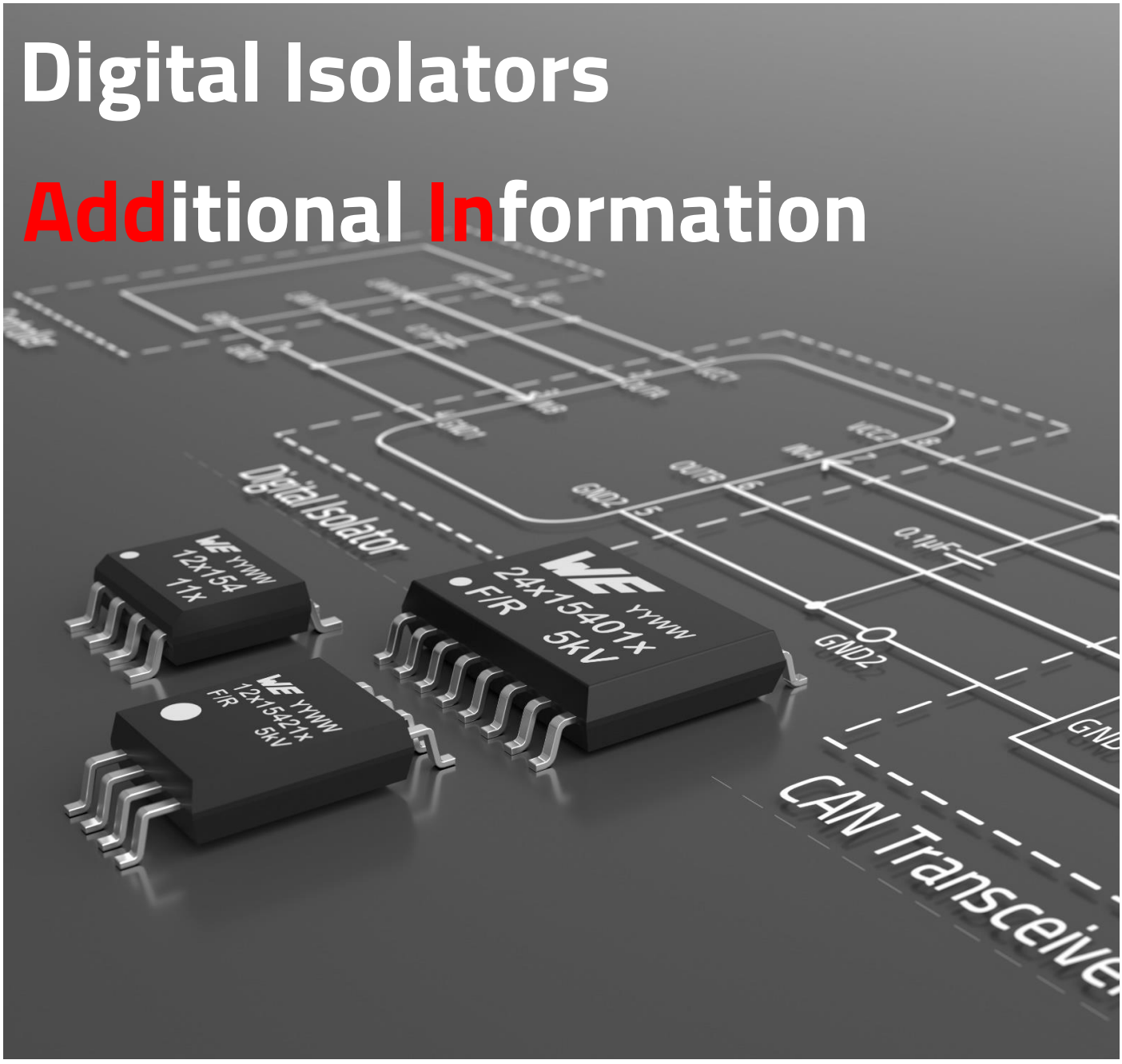
Digital Isolators

Additional Information



Digital Isolators are the reliable solution for galvanic isolation of digital signals. They provide a reliable transmission of high-speed signals, prevent ground potential differences and the appearance of data communication errors or data corruption, and improve noise immunity.

For more information, please visit:
www.we-online.com/digitalisolators

- Simple design-in process
- Design and layout support
- EMI filter design for EN55032 class B
- Evaluation boards for isolators with integrated DC/DC converters
- REDEXPERT for selection

Contents

1. TYPICAL CIRCUIT DIAGRAMS AND STRUCTURES

Table 1: 2-Channel Digital Isolators without Integrated DC/DC Converters (CDIS)

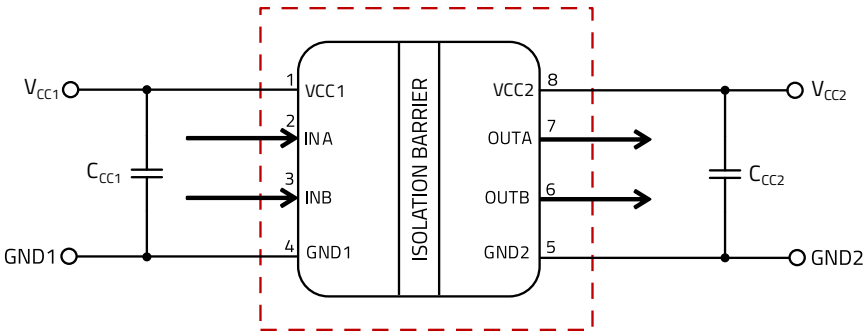
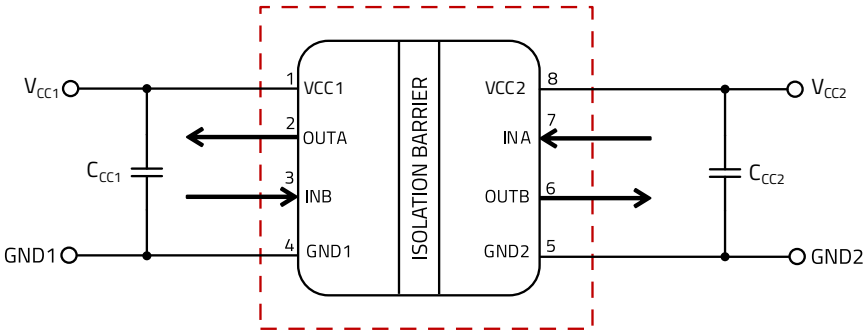
Order Code	Channel Config.	Package	Typical Circuit Diagram
18012015411H	2/0	SOIC-8NB	
18012015411L			
18012015421H		SOIC-8WB	
18012015421L			
18012115411H	1/1	SOIC-8NB	
18012115411L			
18012115421H		SOIC-8WB	
18012115421L			

Table 2: 4-Channel Digital Isolators without Integrated DC/DC Converters (CDIS)

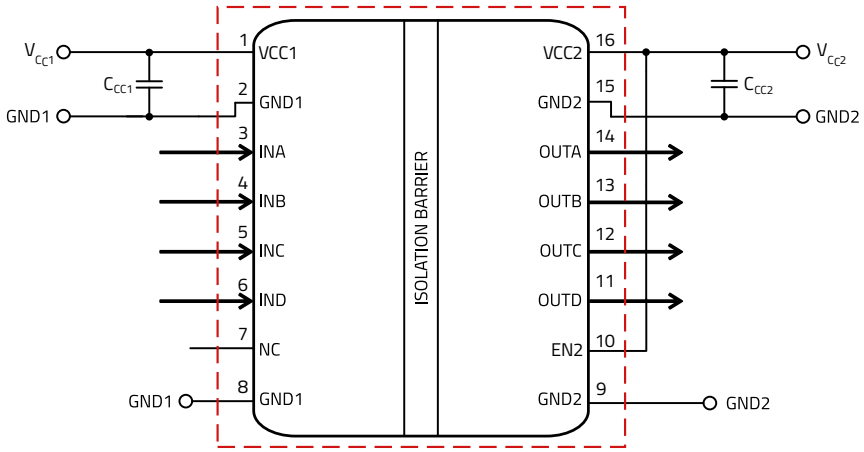
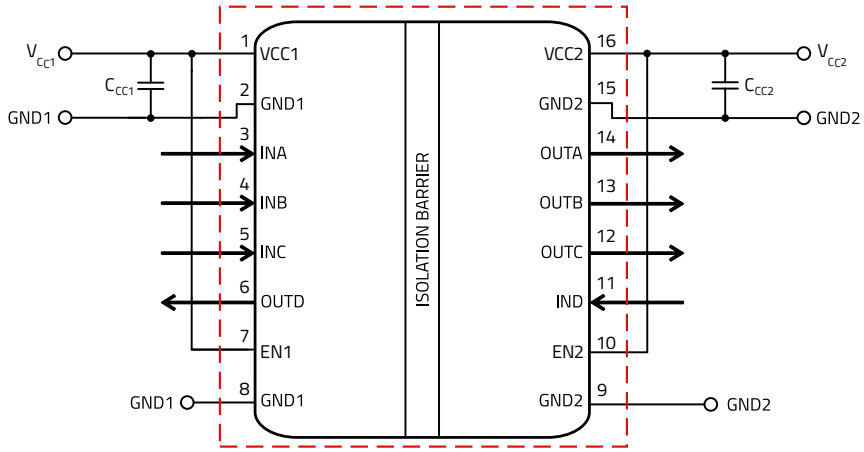
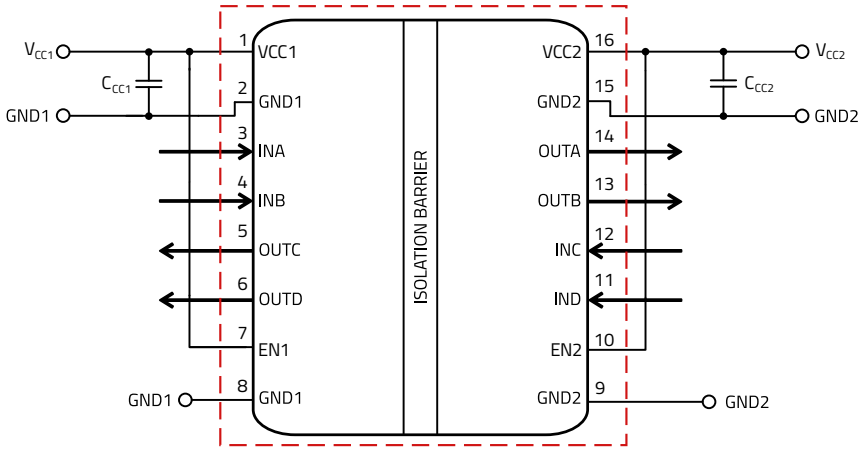
Order Code	Channel Config.	Package	Typical Circuit Diagram
18014015401H	4/0	SOIC-16WB	
18014015401L			
18014115401H	3/1		
18014115401L			
18014215401H	2/2		
18014215401L			

Table 3: 6-Channel Digital Isolators without Integrated DC/DC Converters (CDIS)

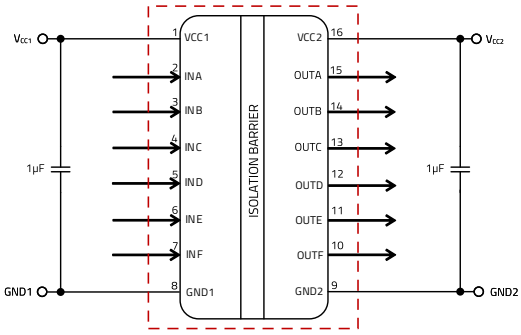
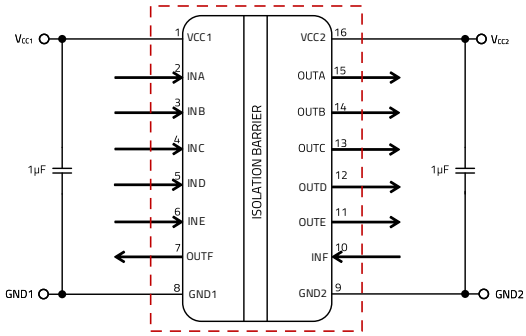
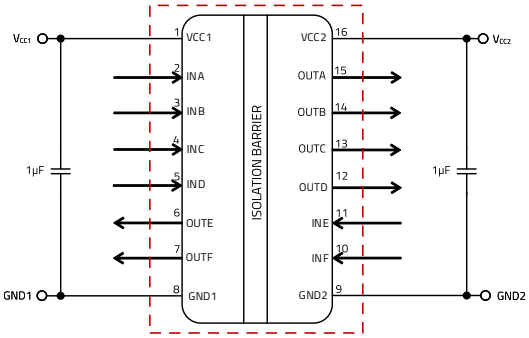
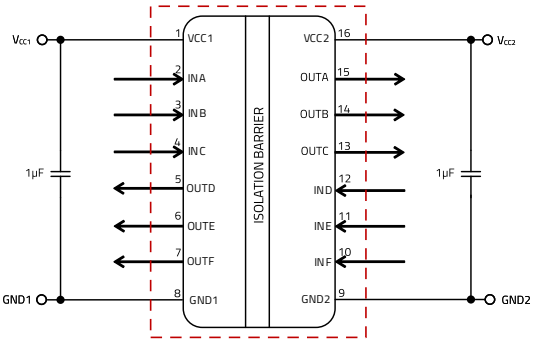
Order Code	Channel Config.	Package	Typical Circuit Diagram
18016004401H	6/0	SOIC-16WB	
18016004401L			
18016104401H	5/1		
18016104401L			
18016204401H	4/2		
18016204401L			
18016304401H	3/3		
18016304401L			

Table 4: 4-Channel Digital Isolators with Integrated DC/DC Converters (CDIP)

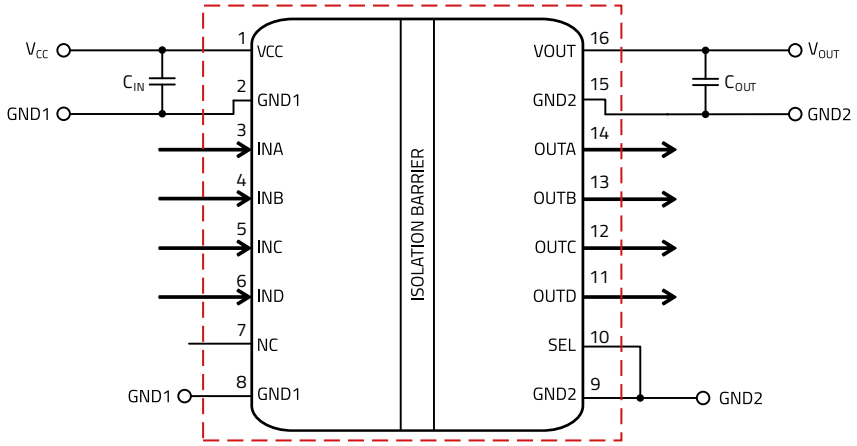
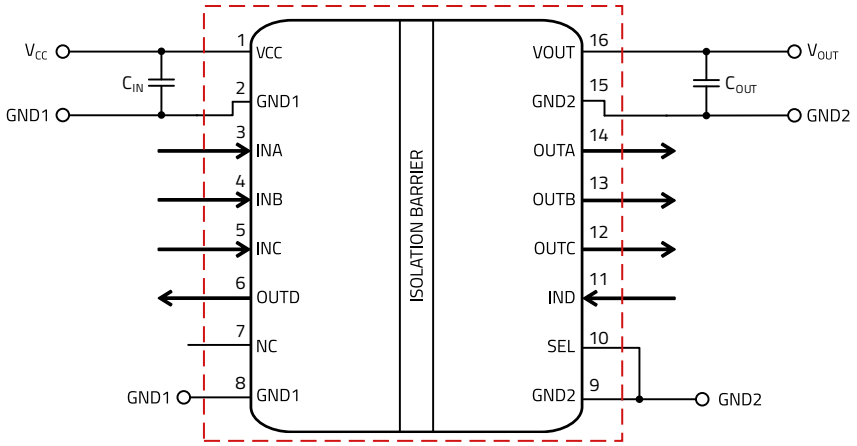
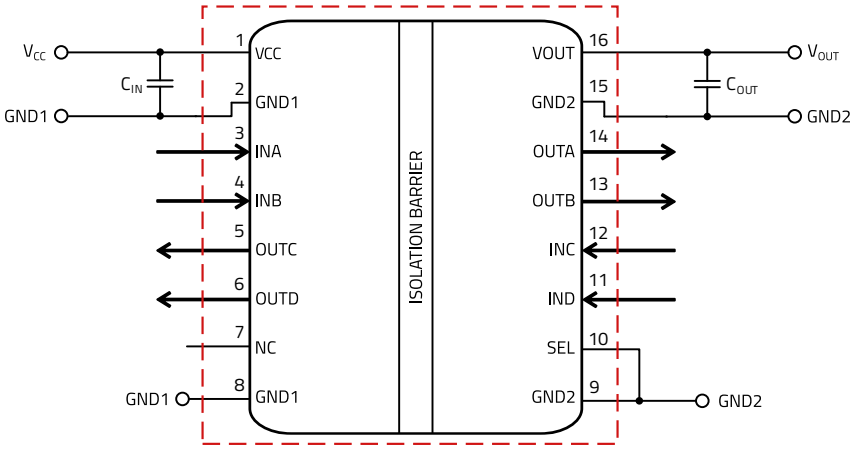
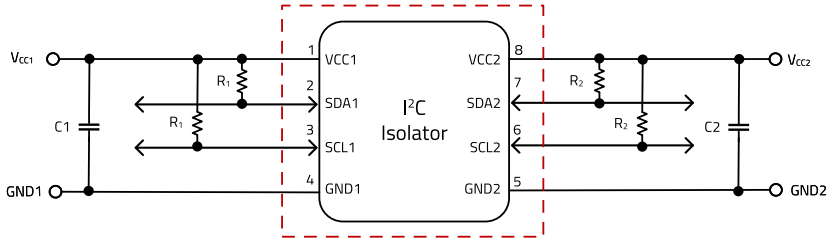
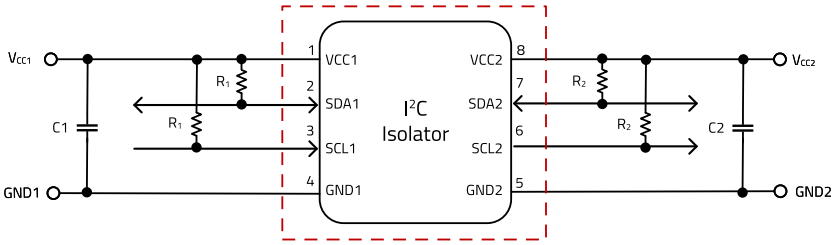
Order Code	Channel Config.	Package	Typical Circuit Diagram
18024015401H 18024015401L	4/0	SOIC-16WB	
18024115401H 18024115401L	3/1		
18024215401H 18024215401L	2/2		

Table 5: 2-Channel Bidirectional I²C Isolators (**CDI2C**)

Order Code	Channel Config.	Package	Typical Circuit Diagram
18032011	2/0	SOIC-8NB	
18032111	1/1		

2. FEATURES

Table 6: Features

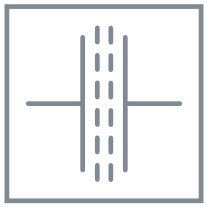
	**Isolation Voltage 3750 V** The digital isolators in the SOIC-8NB package are certified under UL 1577. ❖ Maximum Isolation Voltage V_{ISO}=3750 V_{RMS} for 1 minute ❖ UL File No: E535458
	**Basic Insulation** The digital isolators in SOIC-8NB are certified according to DIN EN IEC 60747-17 (VDE 0884-17). ❖ Maximum repetitive peak isolation voltage V_{IORM}=566 V_{PK} ❖ Maximum working isolation voltage V_{IOWM}=400 V_{RMS} / 566 V_{DC} ❖ Maximum transient isolation voltage V_{IOTM}=5300 V_{PK} ❖ Maximum surge isolation voltage V_{IOSM}=5000 V_{PK} ❖ VDE certification number: 40058073
	**Isolation Voltage 5000 V** The digital isolators in SOIC-8WB and SOIC-16WB are certified under UL 1577. ❖ Maximum Isolation Voltage V_{ISO}=5000 V_{RMS} for 1 minute ❖ UL File No: E535458
	**Reinforced Insulation** The isolators in SOIC-8WB/-16WB are certified according to DIN EN IEC 60747-17 (VDE 0884-17). ❖ Maximum repetitive peak isolation voltage V_{IORM}=1414 V_{PK} ❖ Maximum working isolation voltage V_{IOWM}=1000 V_{RMS} / 1414 V_{DC} ❖ Maximum transient isolation voltage V_{IOTM}=7070 V_{PK} ❖ Maximum surge isolation voltage V_{IOSM}=7070 V_{PK} ❖ VDE certification number: 40058069
	**Data Rate 100 Mbps** Data Rate up to 100 Mbps for 4-channel digital isolators with integrated DC/DC converters ❖ Possibility to transfer digital signals with high-speed data rate up to 100 Mbps
	**Data Rate 150 Mbps** Data Rate up to 150 Mbps for 2- and 4-channel digital isolators without integrated DC/DC converters ❖ Possibility to transfer digital signals with high-speed data rate up to 150 Mbps

Table 7: Features

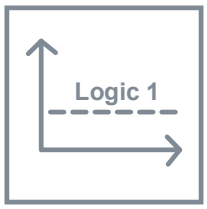
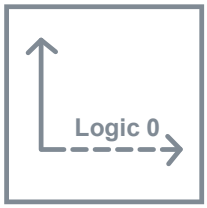
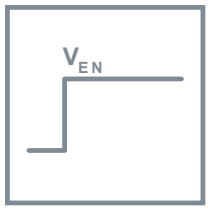
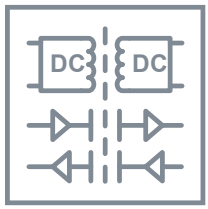
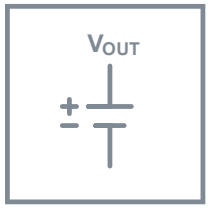
	**Common Mode Transient Immunity (CMTI)** High common mode transient immunity ±150 kV/µs (typical). ❖ Indicates the isolator's ability to maintain reliable operation during rapid common-mode voltage changes ❖ Prevents fast transient noise from coupling through the isolation barrier and affecting signal integrity
	**Default Output High** The predefined state of the default output is **high** when the input channels of the digital isolator are unpowered or the input pins are floating. ❖ The internal high-frequency signal modulator of a digital isolator with a **high** default output state does not operate when the input signal is at a **high** level
	**Default Output Low** The predefined state of the default output is **low** when the input channels of the digital isolator are unpowered or the input pins are floating. ❖ The internal high-frequency signal modulator of a digital isolator with a **low** default output state does not operate when the input signal is at a **low** level
	**Enable** Applicable to 4-channel digital isolators without integrated DC/DC converters. ❖ The output pins on the primary side of the digital isolator are enabled when EN1 is high or open and are in a high-impedance state when EN1 is low. ❖ The output pins on the secondary side of the digital isolator are enabled when EN2 is high or open and are in a high-impedance state when EN2 is low.
	**Integrated Isolated DC/DC converter** The integrated DC/DC converters of the 4-channel digital isolators support up to 650 mW of power.
	**Output Voltage Selection** Allows selection of the output voltage level of the integrated DC/DC converter 3.3 V or 5 V.
	**Fixed Soft Start** The slope of the rise of the output voltage of the integrated DC/DC converter during start-up is fixed. ❖ No overshoot

Table 8: Features

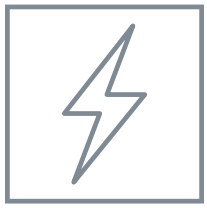
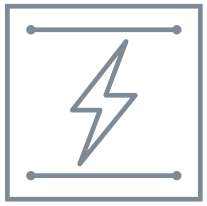
	**Overcurrent Protection** During an overcurrent condition of the integrated DC/DC converter, the output current is limited. ❖ Limits overheating of the device
	**Short-Circuit Protection** The output voltage is continuously monitored and when it drops below a certain threshold, the PFM controller of the integrated DC/DC converter stops switching. ❖ Limits overheating of the device
	**Undervoltage Lockout** The gating pulses for the secondary and primary side full bridges of the integrated DC/DC converter are inhibited in the event of an input voltage below the recommended values. ❖ Avoids undefined behavior of the integrated DC/DC converter during input voltage failures
	**Over Temperature Protection** Turns off the integrated DC/DC converter when the junction temperature exceeds a dangerous limit. ❖ Prevents catastrophic failures during accidental device overheating
	**Low Radiation** The digital isolators with integrated DC/DC converter are compliant with the European standard: EN 55032 class B (CISPR 32) conducted and radiated. ❖ Time-saving design (with the reference layout specified in the data sheet)

Table 9: Features of 2-, 4- and 6-Channel Digital Isolators without Integrated DC/DC Converters (CDIS)

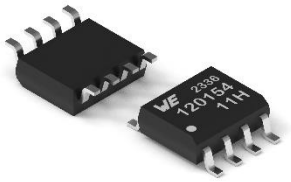
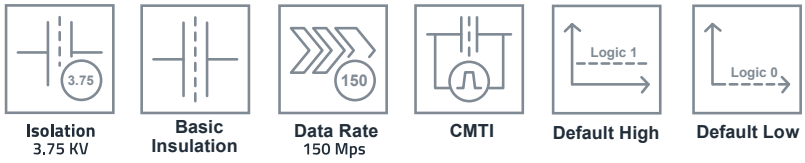
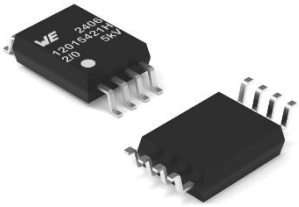
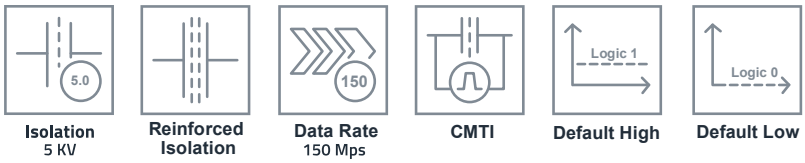
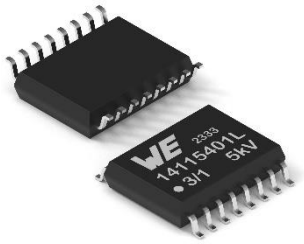
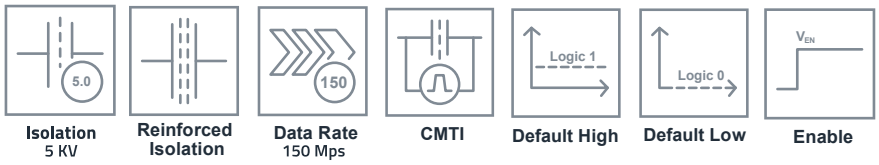
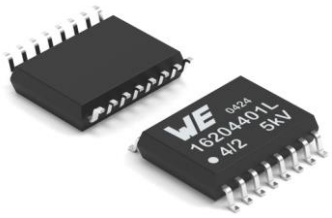
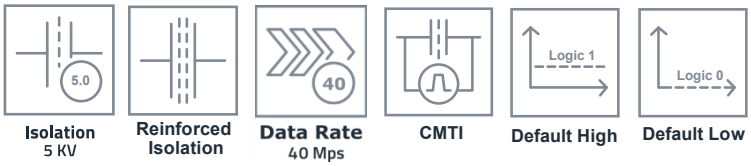
2-Channel Unpowered in SOIC-8NB	
	
2-Channel Unpowered in SOIC-8WB	
	
4-Channel Unpowered in SOIC-16WB	
	
6-Channel Unpowered in SOIC-16WB	
	

Table 10: Features of 4-Channel Digital Isolators with Integrated DC/DC Converters (CDIP)

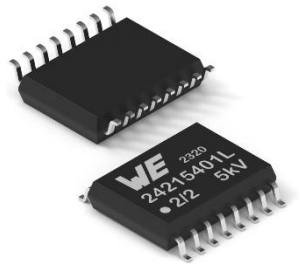
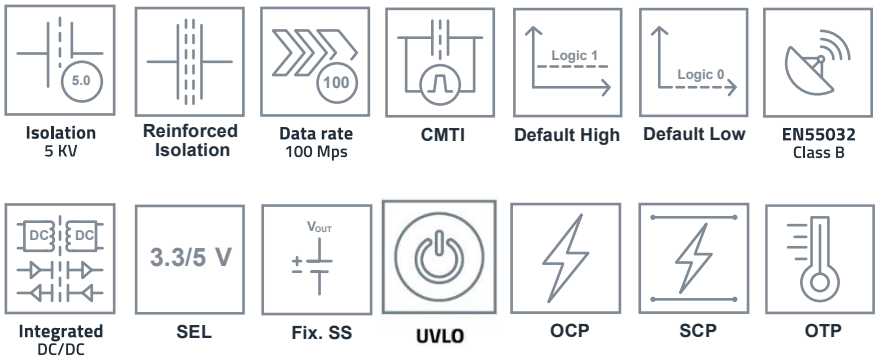
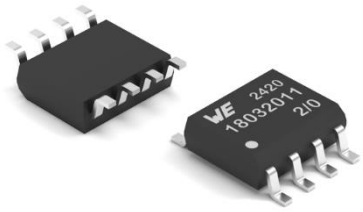
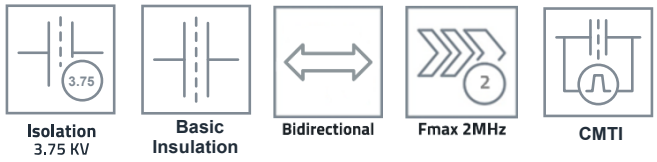
4-Channel Powered in SOIC-16WB	
	

Table 11: Features of 2-Channel Bidirectional I²C Isolators (CDI2C)

2-Channel Bidirectional in SOIC-8NB	
	

3. APPLICATIONS

Table 12: Isolation of **CAN Interface** (2-Channel Unpowered Digital Isolators 180121154x1x)

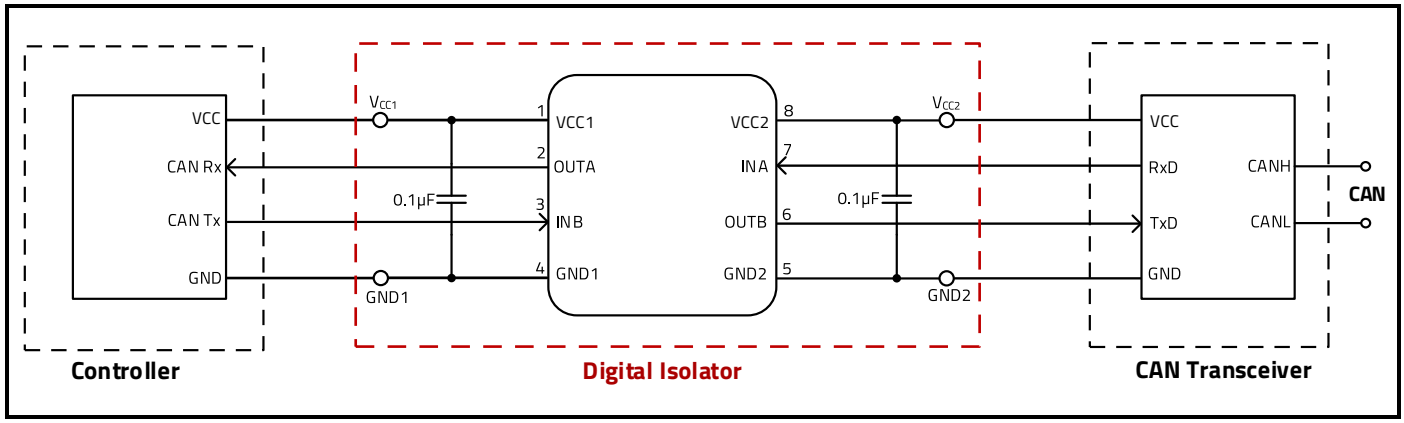


Table 13: Isolation of **RS-232 Interface** (4-Channel Unpowered Digital Isolators 18014215401x)

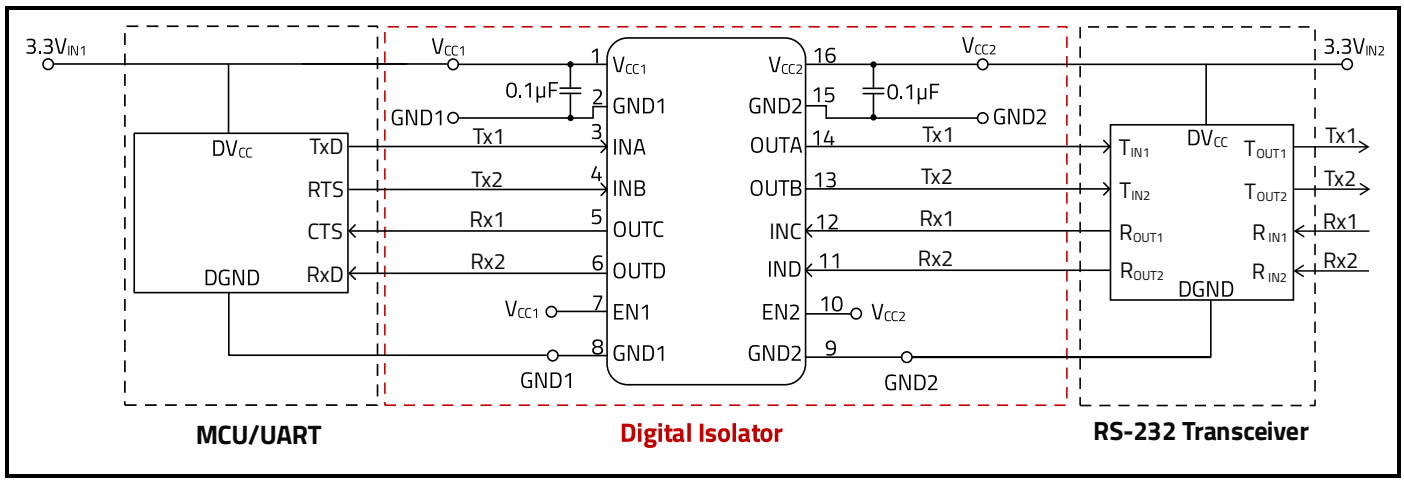


Table 14: Isolation of **RS-485 Interface** (4-Channel Powered Digital Isolators 18024115401x)

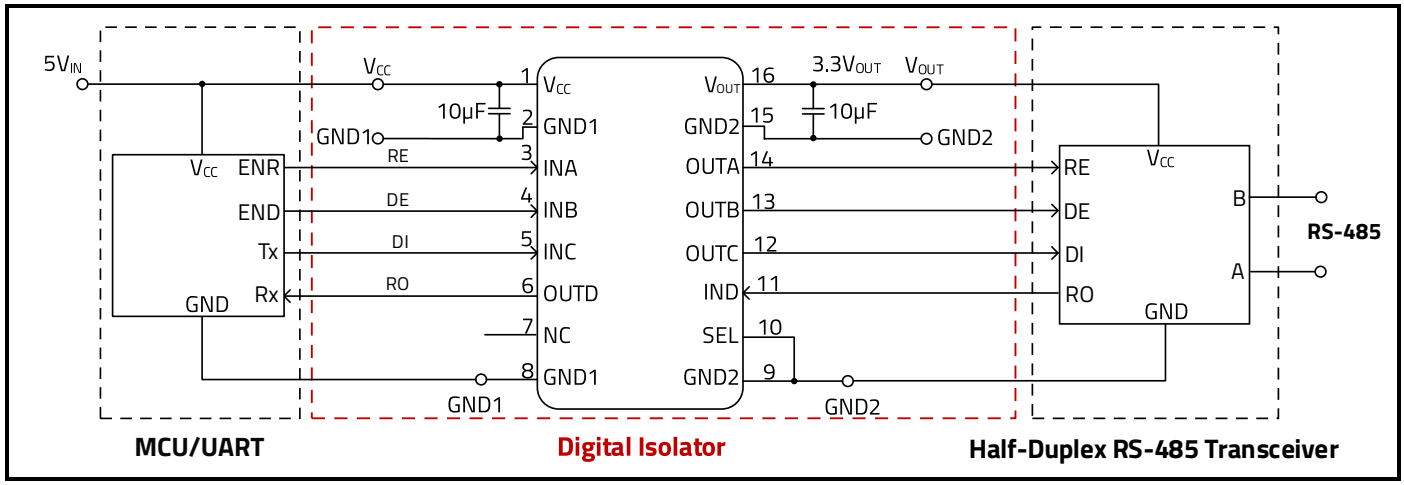


Table 15: Isolation of **SPI Interface** (4-Channel Powered Digital Isolators 18024115401x)

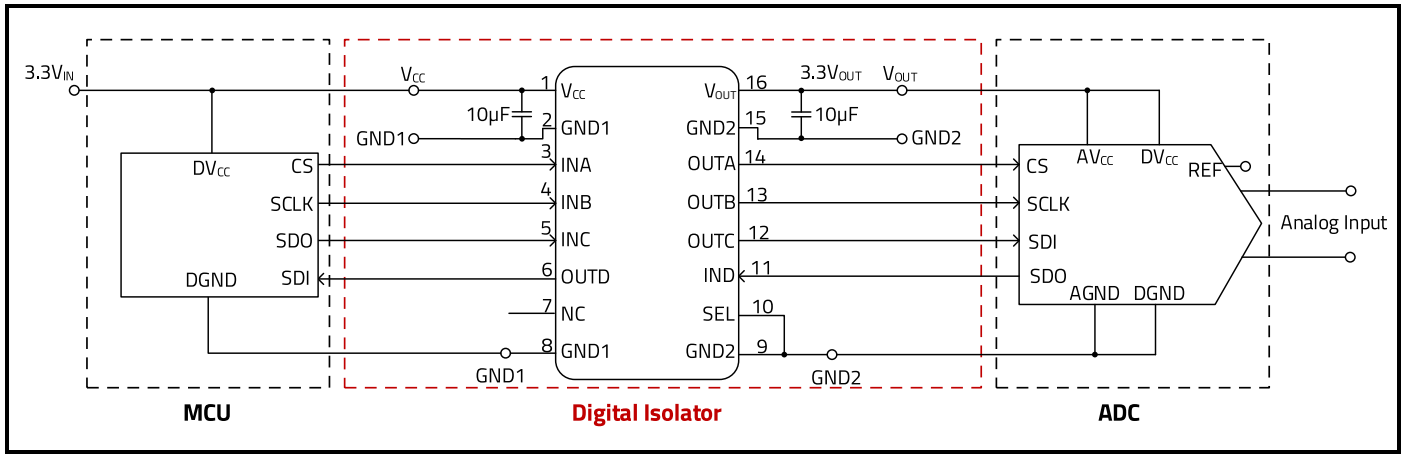


Table 16: Isolation of **Gate Drivers for Power Transistors in SMPS** (4-Channel Unpowered Digital Isolator 18014015401L)

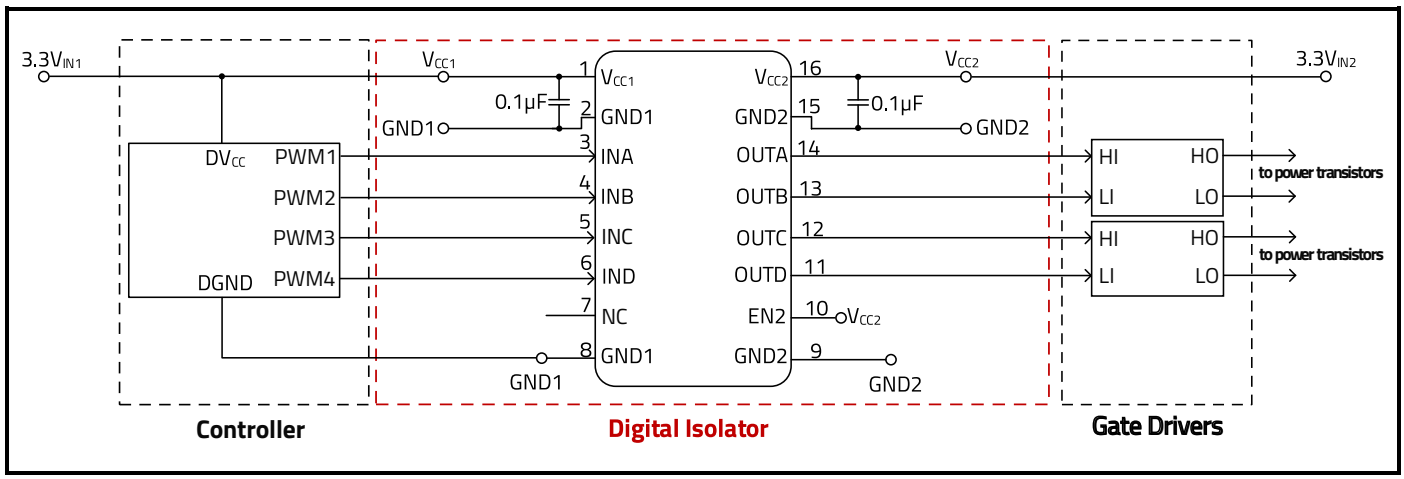


Table 17: **Isolated I² C Communication for ADC Applications** (2-Channel Bidirectional Isolator 18032011)

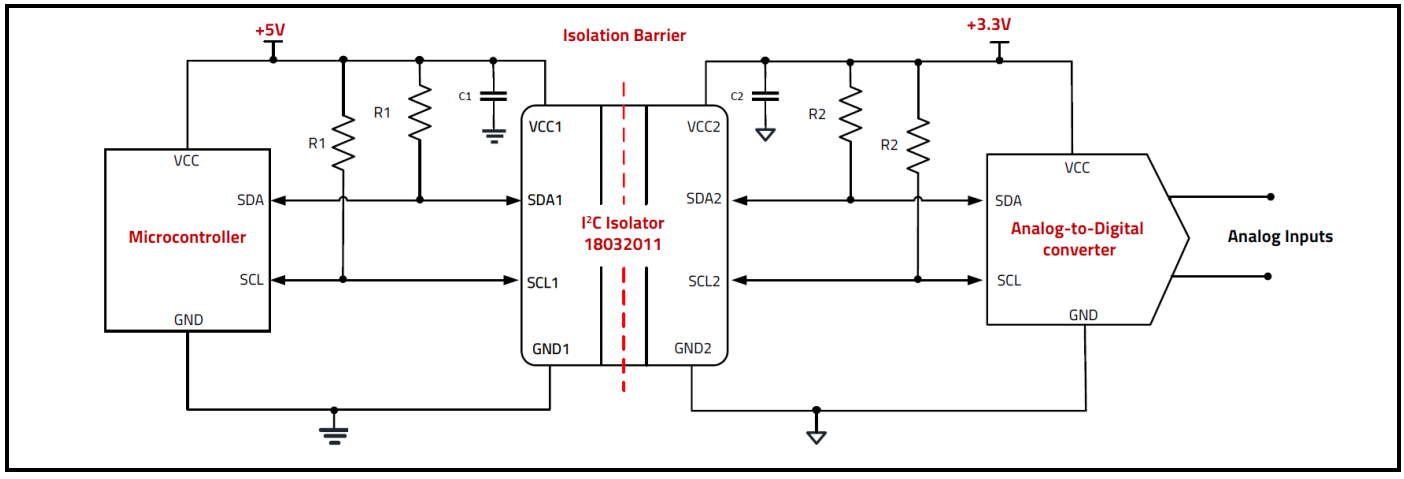
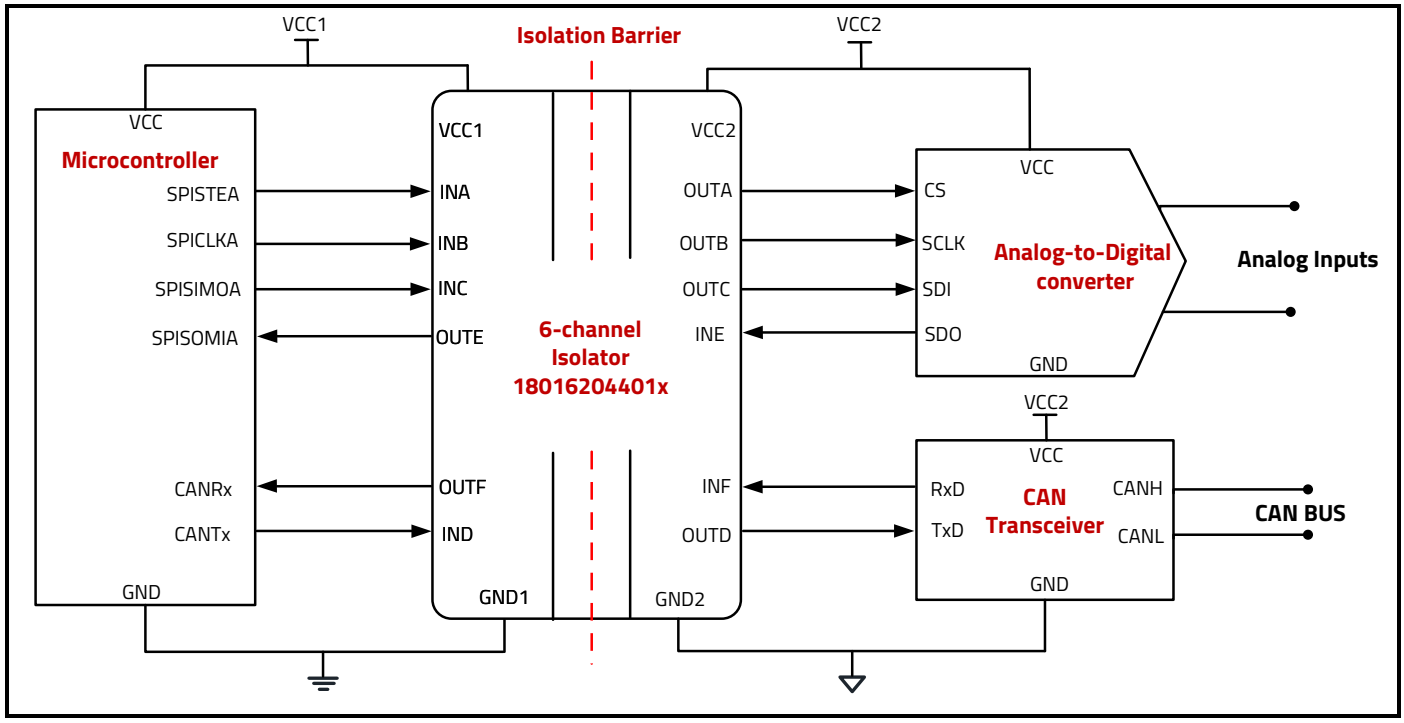


Table 18: **Isolated CAN and SPI interfaces** (6-Channel Unpowered Digital Isolator 18016204401x)



4. MEAN TIME BETWEEN FAILURES (MTBF) AND FAILURE IN TIME (FIT)

Table 19: MTBF and FIT Values of Digital Isolators without Integrated DC/DC Converters (CDIS)

MTBF and FIT data								
MTBF (Hours)	FIT	Usage temp. (°C)	Conf. level (%)	Activation energy (eV)	Test temp. (°C)	Test duration (Hours)	Sample size	Fails
4.10E+08	2.439	55	60	0.7	125	1000	4820	0
1.63E+08	6.129	55	90	0.7				

Table 20: MTBF and FIT Values of Digital Isolators with Integrated DC/DC Converters (CDIP)

MTBF and FIT data								
MTBF (Hours)	FIT	Usage temp. (°C)	Conf. level (%)	Activation energy (eV)	Test temp. (°C)	Test duration (Hours)	Sample size	Fails
2.73E+08	3.660	55	60	0.7	125	1000	3210	0
1.09E+08	9.200	55	90	0.7				

Table 21: MTBF and FIT Values of Bidirectional I^2C Isolators (CDI2C)

MTBF and FIT data								
MTBF (Hours)	FIT	Usage temp. (°C)	Conf. level (%)	Activation energy (eV)	Test temp. (°C)	Test duration (Hours)	Sample size	Fails
4.10E+08	2.44	55	60	0.7	125	1000	4822	0

5. RELIABILITY

Table 22: Reliability Test Overview for Powered (**CDIP**) and Unpowered (**CDIS**) Digital Isolators, I2C Isolators (**CDI2C**)

Test	Reference	Test Conditions
Temperature Cycling	JESD22 Method JA-104	-65°C ~ 150°C 2 cycles per hour 500 cycles
High Temperature Operational Life	JESD22-A108	CDIS/CDIP: 5.5Vin, 1MHz, 50% DC, load capacitance of 15pF, load current is 50%, 5Vout, 105°C, 1000h, daisy chained CDI2C: 5.5Vin, 400 KHz with 50% duty cycle, 125°C, 1000h
Unbiased Highly Accelerated Stress Test	JESD22-A118B	Temperature: 110°C Humidity: 85% R.H. Testing Time: 264h
External Visual	MIL-STD-883-2009	
Physical Dimension	JESD22 Method JB-100	
Mechanical Shock	MIL-STD-202-213	3 shocks in each direction (x, -x, y, -y, z, -z), peak value 100g's, duration 6ms, half-sine, velocity change 12.3ft/sec.
Vibration	MIL-STD-202-204	5g's for 20min, 12 cycles each of 3 orientations, test from 10 Hz to 2000Hz
High Temperature Storage Life	JESD22-A103	Tamb=150°C, 1000h
Low Temperature Storage Life	JESD22-A119	-65°C, 1000h
Five times Reflow	Internal	260°C peak temp.

6. INSULATION SPECIFICATION NUMBERS

Table 23: Insulation Specification Numbers

Match code	Package	Certification Number	
		DIN EN IEC 60747-17 (VDE 0884-17):2021-10	UL 1577
CDIS & CDI2C	SOIC-8NB	40058073	E535458
CDIS	SOIC-8WB	40058069	
	SOIC-16WB		
CDIP	SOIC-16WB		

7. MOISTURE SENSITIVITY LEVEL (MSL)

Table 24: Moisture Sensitivity Level Description

MSL	Floor Life	
	Time	Condition
1	Unlimited	≤ 30° / 85% RH
2	1 Year	≤ 30° / 60% RH
2a	4 Weeks	≤ 30° / 60% RH
3	**168 Hours**	**≤ 30° / 60% RH**
4	72 Hours	≤ 30° / 60% RH
5	48 Hours	≤ 30° / 60% RH
5a	24 Hours	≤ 30° / 60% RH
6	TOL (time of label)	≤ 30° / 60% RH

Table 25: Marking Description

Match code	Package	Mounting	MSL
CDIS & CDI2C	SOIC-8NB	SMD	3
CDIS	SOIC-8WB		
	SOIC-16WB		
CDIP	SOIC-16WB		

8. SOLDERING PROFILE & SOLDERING CYCLES

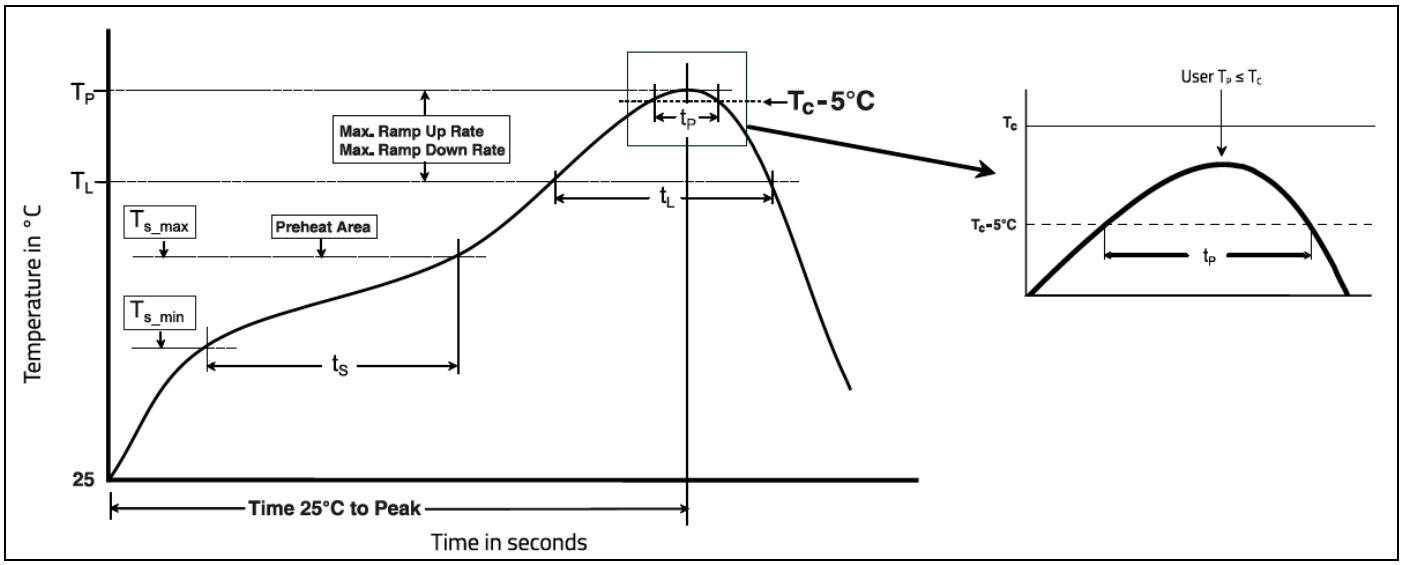


Figure 1: Soldering profile

Table 26: Soldering Profile & Soldering Cycles

Profile Feature	Symbol	Value
Preheat temperature minimum	T_{s_min}	150°C
Preheat temperature maximum	T_{s_max}	200°C
Maximum preheat time from T_{s_min} to T_{s_max}	t_s	60-120 seconds
Liquidus temperature	T_L	217°C
Time maintained above T_L	t_L	60-90 seconds
Classification temperature	T_C	260°C
Peak package body temperature	T_P	$T_P \le T_C$
Time within T_C - 5°C and T_C	t_P	$t_P \le 30$ seconds
Ramp-up rate (T_L to T_p)		3°C/second maximum
Ramp-down rate (T_P to T_L)		6°C/second maximum
Time 25°C to peak temperature		8 minutes maximum

Please refer to JEDEC J-STD020 for further information pertaining to reflow soldering of electronic components.

9. LIFETIME VS STRESS VOLTAGE

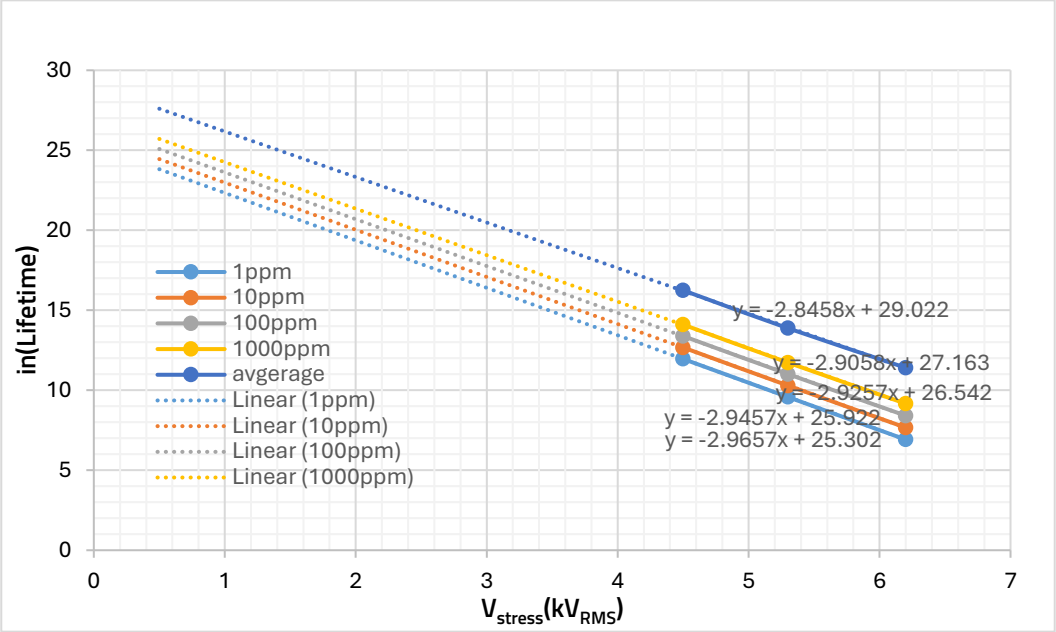


Figure 2: Lifetime vs. V_{stress} for 2- and 4-channel digital isolators without integrated DC/DC converters (CDIS)

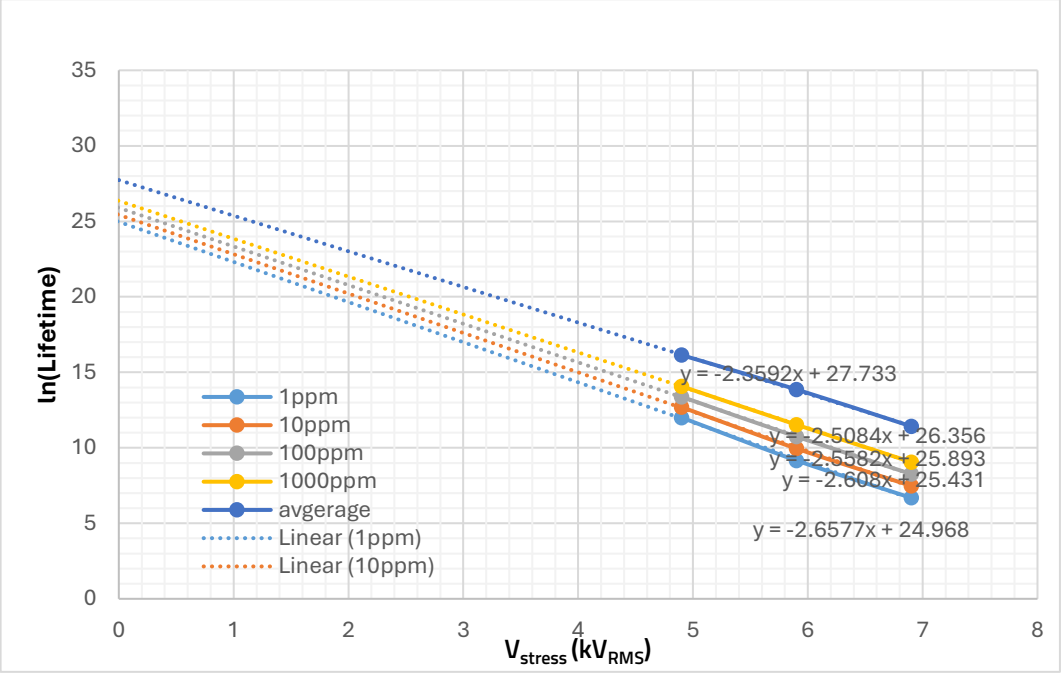


Figure 3: Lifetime vs. V_{Stress} for 4-channel digital isolators with integrated DC/DC converters (CDIP)

Lifetime charts explanation:

- **X-axis:** Continuous stress voltage (Vrms)
- **Y-axis:** Logarithm of working time (dimensionless, converted to time in seconds)

The equation to convert Y-axis values to actual lifetime in years is:

$$n(years) = \frac{e^{y}}{365 \times 24 \times 60 \times 60}$$

Where e^{y} gives time in seconds, dividing by 365×24×60×60 converts seconds into years.

For example, for V_{Stress} = 1 kV_{RMS}, the Y-axis value at 1 ppm failure rate is about 22 for the 4-channel powered and unpowered digital isolators.

$$n(years) = \frac{e^{22}}{365 \times 24 \times 60 \times 60} \approx 113\ years$$

10. IMPORTANT NOTICE

The Note is based on our knowledge and experience of typical requirements concerning these areas. It serves as general guidance and should not be construed as a commitment for the suitability for customer applications by Würth Elektronik eiSos GmbH & Co. KG. The information in the Application Note is subject to change without notice. This document and parts thereof must not be reproduced or copied without written permission, and contents thereof must not be imparted to a third party nor be used for any unauthorized purpose.

Würth Elektronik eiSos GmbH & Co. KG and its subsidiaries and affiliates (WE) are not liable for application assistance of any kind. Customers may use WE's assistance and product recommendations for their applications and design. The responsibility for the applicability and use of WE Products in a particular customer design is always solely within the authority of the customer. Due to this fact it is up to the customer to evaluate and investigate, where appropriate, and decide whether the device with the specific product characteristics described in the product specification is valid and suitable for the respective customer application or not.

The technical specifications are stated in the current data sheet of the products. Therefore the customers shall use the data sheets and are cautioned to verify that data sheets are current. The current data sheets can be downloaded at www.we-online.com. Customers shall strictly observe any product-specific notes, cautions and warnings. WE reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services.

WE DOES NOT WARRANT OR REPRESENT THAT ANY LICENSE, EITHER EXPRESS OR IMPLIED, IS GRANTED UNDER ANY PATENT RIGHT, COPYRIGHT, MASK WORK RIGHT, OR OTHER INTELLECTUAL PROPERTY RIGHT RELATING TO ANY COMBINATION, MACHINE, OR PROCESS IN WHICH WE PRODUCTS OR SERVICES ARE USED. INFORMATION PUBLISHED BY WE REGARDING THIRD-PARTY PRODUCTS OR SERVICES DOES NOT CONSTITUTE A LICENSE FROM WE TO USE SUCH PRODUCTS OR SERVICES OR A WARRANTY OR ENDORSEMENT THEREOF.

WE products are not authorized for use in safety critical applications, or where a failure of the product is reasonably expected to cause severe personal injury or death. Moreover, WE products are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. Customers shall inform WE about the intent of such usage before design-in stage. In certain customer applications requiring a very high level of safety and in which the malfunction or failure of an electronic component could endanger human life or health, customers must ensure that they have all necessary expertise in the safety and regulatory ramifications of their applications. Customers acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of WE products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by WE.

CUSTOMERS SHALL INDEMNIFY WE AGAINST ANY DAMAGES ARISING OUT OF THE USE OF WE PRODUCTS IN SUCH SAFETYCRITICAL APPLICATIONS.

USEFUL LINKS

Application Notes
www.we-online.de/app-notes

REDEXPERT Design Platform
www.we-online.de/redexpert

Toolbox
www.we-online.de/toolbox

Product Catalog
www.we-online.com/products

CONTACT INFORMATION

powermodules@we-online.de
Tel. +49 7942 945 - 0

Würth Elektronik eiSos GmbH & Co. KG
Max-Eyth-Str. 1 · 74638 Waldenburg
Germany

www.we-online.com