

GALVANICALLY ISOLATED VOLTAGE MEASUREMENT MADE EASY WITH DIGITAL ISOLATORS

Artem Beliakov

WURTH ELEKTRONIK MORE THAN YOU EXPECT





Digital Isolator Application

Great variety of success stories



Industrial Automation

- Communication Interfaces:
 - ✓ Field Bus
 - ✓ Industrial Ethernet
 - ✓ RS-232 and RS-485
 - ✓ CAN-BUS
 - ✓ Serial Peripheral Interface (SPI)
- Programmable Logic Controllers (PLC)
- Sensors and Modules
- Motor control



Solar and Industrial Power Supplies

- Server SMPS
- Cloud Power Supplies
- Uninterruptible Power Supplies (UPS)
- Solar Inverters
- Telecom DC-DC brick
- Telecom SMPS
- Lighting



Electric Vehicles Charging and Electric Meters

- Battery Managment Systems (BMS)
- On Board Chargers
- Charging Stations
- DC/DC converters
- Smart Electric Meters
- Protection relays and grid
- Healthcare



<u>Need for Signal Isolation!</u>

Application example - warehouse logistics







Potential-free voltage measurement - transmitter and receiver circuit





Potential-free voltage measurement - transmitter and receiver circuit



Block circuit of the transmitter for potential-free measurement of voltage



Block circuit of the receiver for potential-free measurement of voltage



Output voltage as a function of the input voltage



Additional sources









Digital Isolator Application

Reduction of CM-current, principle with Y-Cap



Digital Isolator Application

Layer structure - Stitching Cap - Layout Version 2 - Receiver

Internal 1 Layer



- Area of overlap :
- 77 mm x 50 mm = $3850 \text{ mm}^2 / \text{C}_{\text{FR4}}$: 0,25 pF/mm2
- C_{PCB}: ca. 1nF = Y-Cap

BOTTOM Layer



Interne 2 Lage





Digitale Isolatoren Applikationen

Results EMC measurement (radiated emission) 4-layer with PCB coupling capacitance as Y-capacitance



Digital Isolator Application

Results EMC measurement 2-layers and 4-layers PCB



Receiver

2-layer PCB

- 4-layer PCB
- Y-Cap approx. 1nF by superimposing the layers



Service & Support

Design Example - Layout recommendation from the data sheet











Most critical properties of digital isolators

Overview



UL & IEC/VDE





UL & IEC/VDE

		UL 1577		IEC 60747-17 / VDE 0884-17 ⁽¹⁾
 A certified device's isolation barrier must withstand a certain level of RMS AC voltage (Viso) for 60 seconds At the same time, a digital isolator must withstand an isolation test voltage of 1.2 x Viso for 1 second 				 Maximum Working Isolation Voltage (VIOWM) The maximum continuous working voltage that can be applied to the isolation barrier continuously over the lifetime of a digital isolator without degrading its functionality (defined as RMS- or DC- voltage).
				 Maximum Repetitive Peak Isolation Voltage (VIORM)
	Max. withstanding isolation voltage (V _{ISO(max})) for 60 seconds			The maximum repetitive peak voltage that can be continuously
	2-cha	innels	4-channels	applied to the isolation barrier over the lifetime of a digital isolator
	SOIC-8NB	SOIC-8WB	SOIC-16WB	without reducing its functionality (defined as a peak value).
	3750 V _{RMS}	5000 V _{RMS}	5000 V _{RMS}	
				 Maximum Transient Isolation Voltage (Vютм) The maximum peak voltage that can be applied to the isolation barrier for 60 seconds (defined as a peak voltage value).
				 Maximum Surge Isolation Voltage (VIOSM) The maximum instantaneous value of a voltage pulse (1.2/50µs waveform) that an isolator can tolerate (defined as a peak value). (1) Interpreted meaning based on the application



IEC/VDE (Basic & Reinforced Isolation)

Levels of Isolation

- Functional isolation provides only necessary isolation for the correct operation of the system and doesn't protect against electric shock.
- Basic isolation provides protection against electric shock in addition to functional isolation.
- Compared to an isolator that provides basic isolation, an isolator that provides **reinforced isolation** has higher test voltage requirements.

Symbol	IEC 60747-17 (VDE 0884-17)			
Symbol	Basic Isolation	Reinforced Isolation		
Package	SOIC-8NB	SOIC-8WB /-16WB		
VIOSM - max. surge isolation voltage	5000 Vpk	7070 Vpk		
Test	Vtest = 1.3 x Viosm Vtest = 6.5kV	Vtest = 1.6 x Viosm Vtest = 11.3kV ⁽¹⁾		
Failure rate over lifetime	≤1000 ppm	≤1 ppm		



⁽¹⁾ The minimum surge voltage for reinforced isolation should be greater than 10kV.



UL Certification

UL Product iQ ®			ENGLISH - U Solutions
	Search UL Certification Inform	ation	11 12
	Q E535458	× Search	
			CALL
2 Results :: K	eyword: "E535458"		
Document	Company Name	Product Description	
FPPT2.E53	Wuerth Elektronik eiSos GmbH & Co. KG	Nonoptical Isolating Devices - Component	

https://productiq.ulprospector.com/en/search (more detailed information requires registration)



VDE Certification

VDE le	esting and C	ertification		å	Search for	Q Ke
Marks and Certifica	ates Our portfolio	Your industry	My current orders	VDE Global	About us	
Search wi With the synonym hits in no time. Note: When search letters and enter th HA012345 > 0123 The search result w • the company • the selected • the VDE certi The detail information Information for the • the company • type designa • which VDE m • important tee	th reference r and full text search engin hing for a certificate num he complete number with 45) will present: r name product category (i.e. wai ficate number on button for the detail in tion vill provide you with respective product: r address tion nark was granted chnical data	number he you will have the re ber with HA or NA, or the leading zero (exa shing machine) formation important additional	equired Certific 4005	Ate No. 3073 Register-No. imer No. oany ict Search		
1 Result	Company F	Product	Fir	st types		Certificatio
Gertinoate NO.	oompany P	loudot	FI	ы құрез		Gertindatio

IEC 60747-17 (VDE 0884-17)

Semiconductor devices - Part 17: Magnetic and capacitive coupler for basic and reinforced insulation

SOIC-8WB /-16WB: Certificate number 40058069 → Reinforced Isolation

SOIC-8NB: Certificate number 40058073

ightarrow Basic Isolation

www.vde.com/tic-en/marks-and-zertificates/vde-approved-products/search



<u>Package</u>

Clearance and Creepage Distance



	SOIC-8NB	SOIC-8WB	SOIC-16WB	
Clearance	4 mm	8 mm	8 mm	
Creepage	4 mm	8 mm	8 mm	



Package

Comparative Tracking Index

- Comparative Tracking Index (CTI) indicates the ability of the package mold compound to withstand constant high voltage stress without surface degradation.
- A higher CTI means a smaller package (smaller creepage distance) for the same operating voltage.

Material Group	CTI (V _{RMS})		
Group I	>600		
Group II	400 to 600		
Group Illa	175 to 400		
Group IIIb	100 to 175		

• The WE digital isolators provide CTI of more than 600 VRMs and correspond to the material group I.



Timing Characteristics

Data Rate



Timing Characteristics

Propagation Delay



Propagation delay	Channel-to-channel output skew time	Part-to-part output skew time	
15 – 20 ns	2.5 ns	4.5 ns	



Default Output State

Difference and Application



- The modulator of the digital isolator with low default output state transmits high frequency signals through the isolation barrier only when the input has a high signal level.
- And vice versa, the modulator of the digital isolator with high default output state transmits high frequency signals through the isolation barrier only when the input has a low signal level.

Application

Default Output High

I2C, UART, RS-232, RS-485, SPI, CAN and other interfaces that have a high logic level in standby mode (idle mode): less power consumption, because the internal modulator of high frequency signals is not operating during standby mode.

Default Output Low

- Switch mode power supplies (SMPS) to isolate gate drivers from microcontrollers for safety reasons
- SPI and CAN in case there are low in standby (less power consumption)



Current Consumption

DC Mode and Dynamic Mode

	DC	mode	Dynamic mode			
	Supply voltage 5V		Supply Voltage SV			
	Default mode	Non-derault mode				
Primary side current	1 /	28	77	3 1	11 1	
consumption, mA	1.4	2.0	۷.۷	J.1	1 1. 1	
Secondary side current	13	29	23	3 1	116	
consumption, mA	C.1	2.5	2.5		11.0	



18012115411H



Common Mode Transient Immunity (CMTI)

Main advantages of a high CMTI level



Main benefits of a high CMTI level:

- Signal Integrity: Maintains data reliability even in fastchanging voltage environments
- Noise Immunity: Resists EMI and electrical noise, preventing errors
- System Stability: Ensures safety and stability in high-voltage systems
- High-Speed Compatibility: Supports high-speed data without mistakes
- Extended Application Range: Suitable for harsh environment with strong magnetic fields and overvoltage applications like motor control and automation
- Longer Life and Reliability: reducing stress on internal components, resulting in increased reliability and longer life in challenging environments

WE' digital isolators offer a CMTI level of $\pm 150 \text{ kV/}\mu\text{s}$



Digital Isolator Application

Great variety of success stories



Industrial Automation

- Communication Interfaces:
 - ✓ Field Bus
 - ✓ Industrial Ethernet
 - ✓ RS-232 and RS-485
 - ✓ CAN-BUS
 - ✓ Serial Peripheral Interface (SPI)
- Programmable Logic Controllers (PLC)
- Sensors and Modules
- Motor control



Solar and Industrial Power Supplies

- Server SMPS
- Cloud Power Supplies
- Uninterruptible Power Supplies (UPS)
- Solar Inverters
- Telecom DC-DC brick
- Telecom SMPS
- Lighting



Electric Vehicles Charging and Electric Meters

- Battery Managment Systems (BMS)
- On Board Chargers
- Charging Stations
- DC/DC converters
- Smart Electric Meters
- Protection relays and grid
- Healthcare







Application Example

Isolated RS-485 interface



* The board is optimized for 10 Mbps data rate and 10 m cable length.

Input Voltage: Output Voltage: Isolation Voltage: Data Rate:

3.15 to 5.5 V 3.3 V 5000 Vrms up to 10 Mbps* (half-duplex)

- 1 RS-485 input
- 2 Line filter and TVS diodes
- 3 Half-Duplex RS-485 Transceiver
- 4 4-channel digital isolator with integrated DC/DC
- 5 LC-filter for DC/DC converter
- 6 Connector for Vcc
- 7 To controller



Portfolio

4-channel digital isolators with integrated DC/DC converter



Evaluation Boards are available



www.we-online.com/en/components/products/DIGITAL-ISOLATORS-EVB



Portfolio

2- and 4-channel digital isolators without integrated DC/DC converter





DIGITAL ISOLATORS – THE NEXT STEP IN SIGNAL PROTECTION

Artem Beliakov

k/F

WURTH ELEKTRONIK MORE THAN YOU EXPECT