DIGITAL ISOLATORS

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DIGITAL ISOLATORS

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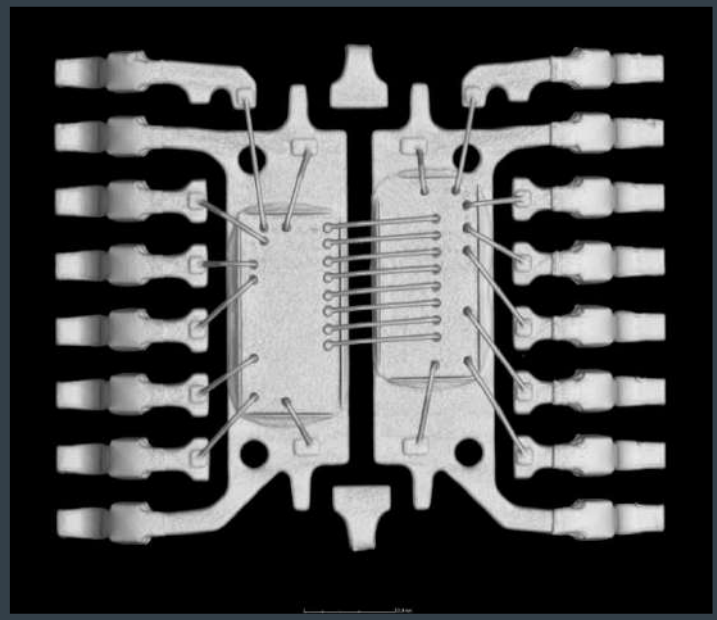
- Technology Overview
- Applications
- WE Portfolio
- WE Support
- Demo

** Some presentation images have clickable web links*

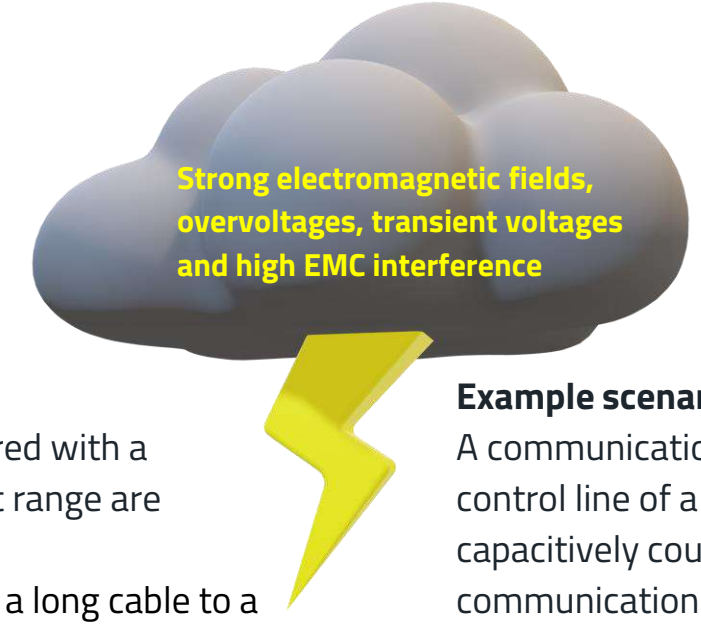
TECHNOLOGY OVERVIEW

Digital Isolator

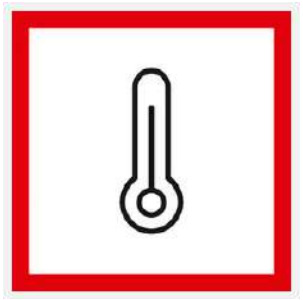


INTRODUCTION

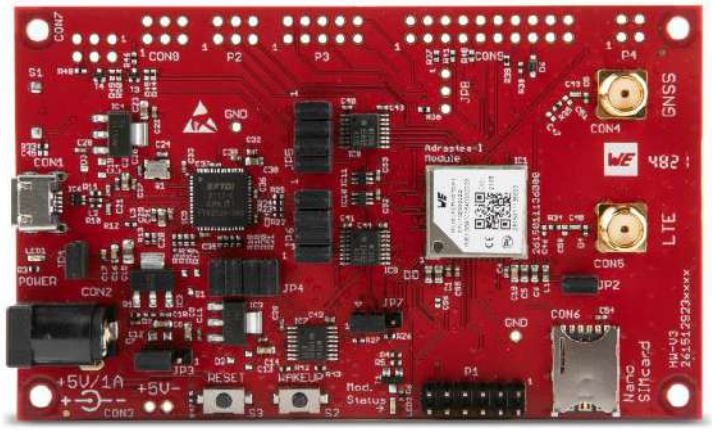
Use-case



Example scenario 1:
The temperature of a motor is measured with a thermocouple, voltages in the millivolt range are generated.
If these voltages are transmitted over a long cable to a central control unit that refers to a different earth potential, the measurement signal is **distorted by the potential differences.**



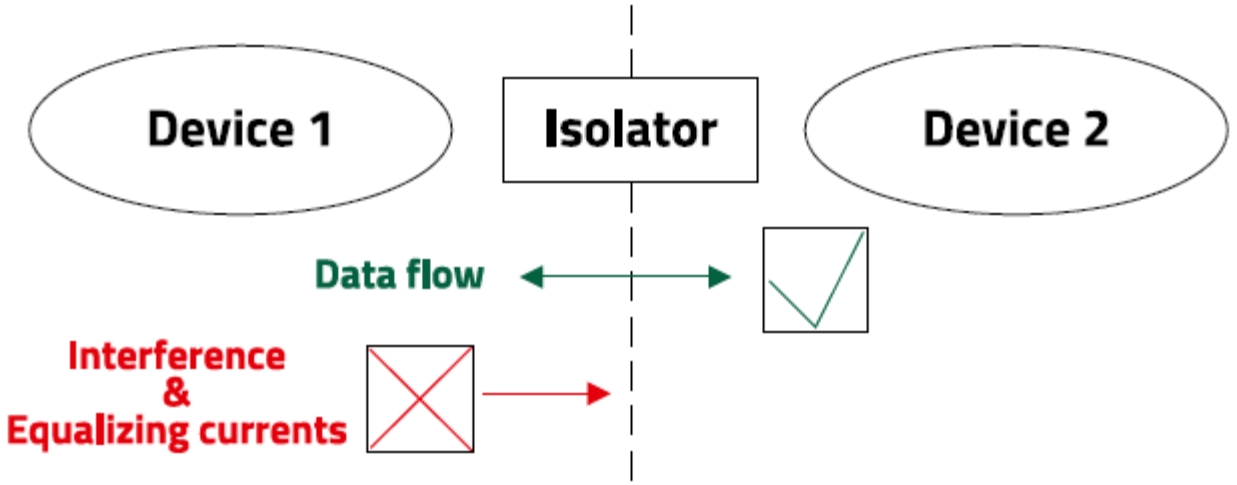
Example scenario 2:
A communication line is laid unfavorably close to a control line of a frequency inverter, the pulses are capacitively coupled and the signals in the communication line **oscillate with the pulse pattern of the frequency inverter.**



INTRODUCTION

Why we need isolation?

- Two major challenges in electronics environment.
  - Interference-free data communication.
  - Personnel and product safety.
- **Galvanic isolation** – used to separate electrical zones with different potentials, no direct conduction path.
  - Goal is transferring signal without unwanted current flowing between two circuits.
  - Prevents electric shocks for end users especially with different ground references.



DIGITAL ISOLATOR

Why we need isolation?

Digital isolators perform the essential function of **electrically isolating circuits** while **ensuring the smooth transfer of data** between different parts of the system.

Security/Safety

- You need a galvanic isolation for safety (electrical shock, overvoltage)
- Devices operated from mains, applications with direct patient contact

Measurements

- You need a galvanic isolation for measurements (humm loops)
- Different current loops / electrical grounding
- The data must be recorded from the object in such a way that the probe does not influence the quantity being measured as precise as possible.

Electromagnetic Disturbances

You need a galvanic isolation to avoid or prevent EMC issues.

CAPACITIVE TECHNOLOGY

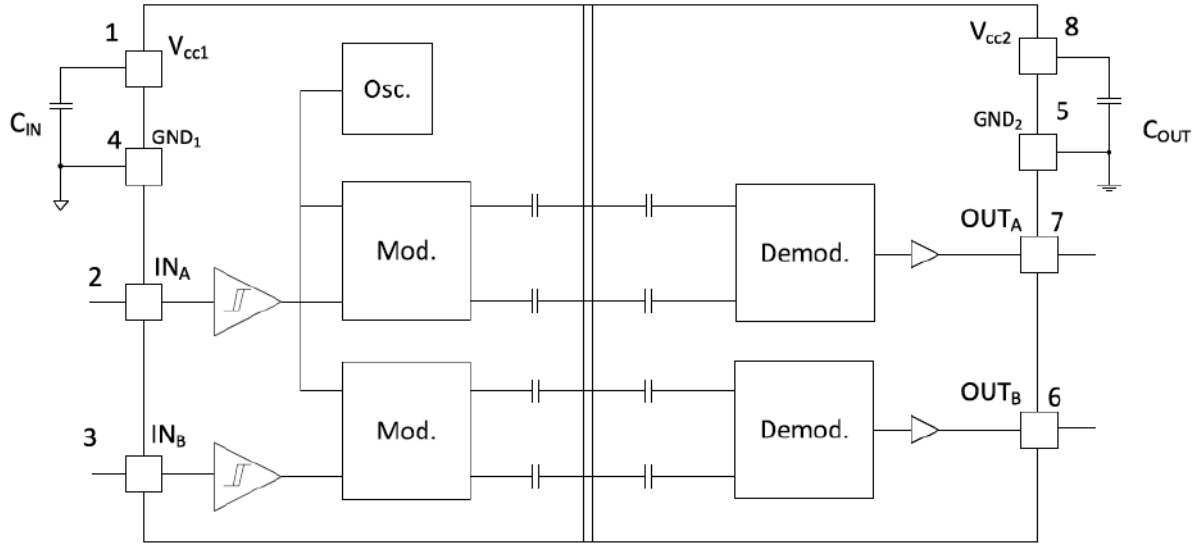
Design Principle

- **Primary Side / Transmitter**
  a) Modulator
    - Signal transmission through the isolation barrier is realized by on/off keying (OOK) – e.g. presence of carrier signal is bit 1, without carrier signal is 0.

  b) Oscillator
    - used to modulate the Schmitt-triggered input signal.

- **Secondary Side / Receiver**
  a) Demodulator
    - is used to pre-amplify, filter and reconstruct the input signal.

  b) Buffer
    - amplifies the signal to the required level.

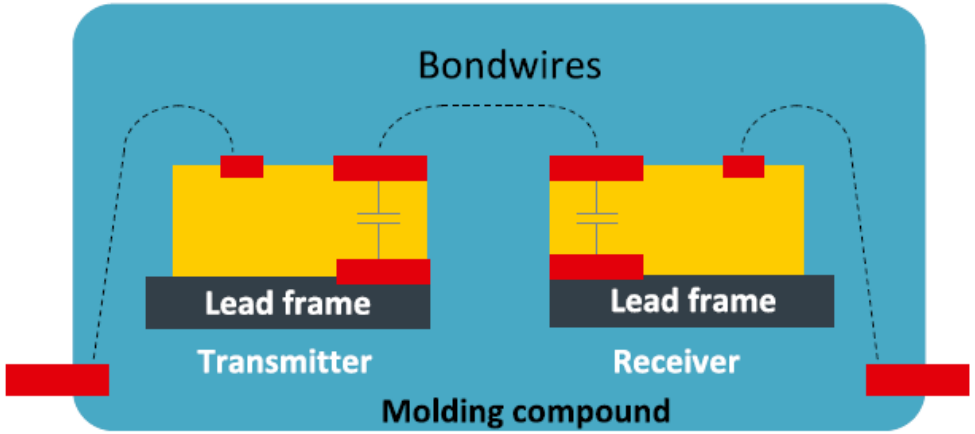


CAPACITIVE TECHNOLOGY

Construction and Features

- Manufactured using standard CMOS technology.
- The capacitors of the transmitter and the receiver are deposited on a lead frame.
- The dielectric material between the capacitor plates serves as a galvanic isolation barrier.
- SiO_2 is used as the insulating material as it has much higher dielectric strength of 500 MV/m (vs. Polyimide), means that it requires considerably less space for the isolating gap.
- The two capacitors are wire-bonded in series.
- To protect the entire structure, the die and lead frame are molded using a standard IC assembly process.

- **Highlights**
  - Can accommodate high speed data transfer.
  - Compact design.
  - Low power consumption.
  - Low sensitivity to magnetic field and RF noise.
  - Less expensive.



Basic structure of a capacitive digital isolator IC.

KEY PARAMETERS

Datasheet information

- **Data rate**
  - The number of bits that are conveyed or processed per second.
- **Isolation voltage**
  - Voltage level (in kV) that can be insulated for a period of time (60 seconds).
- **Surge voltage**
  - Short time sudden voltage increase can be insulated by isolator
- **Propagation delay**
  - is the time it takes for a digital signal to pass through the internal circuits and structure of a digital isolator from input to output.
- **Common Mode Transient Immunity (CMTI)**
  - is Maximum Possible Rate of Rise / Fall of the Common Mode Voltage between two isolated circuits.
- **Default output**
  - Predefined state of output pin when the input channel of isolator is unpowered.

18014x15401x
Digital Isolator
WPME-CDIS - Capacitive Digital Isolator Standard

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

4 Channel Digital Isolator

DESCRIPTION

The CDIS 18014x15401x is a 4 channel digital isolator series that provides capacitive isolation between the primary and secondary sides of the device.

The digital isolator requires two supply voltages, one for the primary side and one for the secondary side.

The CDIS digital isolator ensures fast time to market and low development costs.

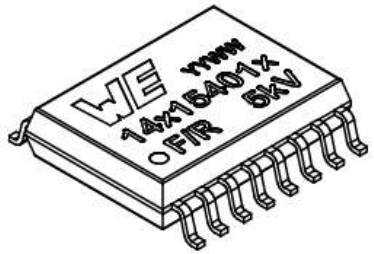
The digital isolator is available in an SOIC-16WB package (10.3 x 10.3 x 2.65)mm.

FEATURES

- Reinforced isolation: 5kV$_{RMS}$ for 60s
- Input voltage range: 2.375V to 5.5V
- Data rate up to 150Mbps
- ±150kV/µs typ. CMTI
- Available channel configurations: 4/0, 3/1 and 2/2
- Default channel output status: high or low
- Low propagation delay: 12ns typ.
- Ambient temperature range: -40°C to 125°C
- RoHS and REACh compliant
- UL1577 recognized
- DIN EN IEC 60747-17 (VDE 0884-17):2021-10 certified

TYPICAL APPLICATIONS

- Isolated communication interfaces (SPI, CAN, RS-232. RS-485)
- Motor control
- Battery management systems
- Solar inverters
- Test and measurement systems
- Programmable logic controller (PLC) interfaces



Click here for parameter details in the WE App note ANS021.

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SAFETY STANDARDS

Isolation Specifications

- The primary function of digital isolators is to ensure the safety of equipment and people.
- Whenever different voltage levels can damage sensitive circuitry or injure a person, isolation is required.
- International safety standards regulate the testing of isolation voltage and many other isolation characteristics.
- All standards provide methods, parameters and requirements for testing.

International	Germany	US
IEC 60747-17	DIN EN IEC 60747-17 (VDE 0884-17)	UL 1577
The first international standard for digital isolators	German version of international IEC 60747-17 standard	Standard for optocouplers. Digital Isolators are allowed to be certified according to this standard

SAFETY STANDARDS

Isolation Specifications

- **DIN EN IEC 60747-17 (VDE 0884-17):2021-10**
  - Maximum Working Isolation Voltage (V_{IOWM})
    - defines 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, which is defined as RMS- or DC-voltage.
  - Maximum Repetitive Peak Isolation Voltage (V_{IORM})
    - This is the maximum repetitive peak voltage that can be continuously applied to the isolation barrier over the lifetime of a digital isolator without reducing its functionality, which is defined as a peak value.
  - Maximum Transient Isolation Voltage (V_{IOTM})
    - This is the maximum peak voltage that can be applied to the isolation barrier for 60 seconds. The characteristic is defined as a peak voltage value.
  - Maximum Surge Isolation Voltage (V_{IOSM})
    - A maximum instantaneous value of a voltage pulse (1.2/50 µs waveform) that an isolator can tolerate, which is defined as a peak voltage value.

- **UL 1577**
  - Maximum withstanding isolation voltage $V_{ISO(max)}$
    - Defines the isolation barrier must withstand a certain level of RMS AC voltage (V_{ISO}) for 60 seconds.

18024x15401x
Digital Isolator
WPME-CDIP - Capacitive Digital Isolator Powered

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

9 APPROVALS

Table 12: Approvals.

STANDARD	DESCRIPTION
UL 1577	UL File No: E535458
DIN EN IEC 60747-17 (VDE 0884-17):2021-10	VDE certification number: 40058069

DIN EN IEC 60747-17 (VDE 0884-17):2021-10				
V_{IORM}	Max. repetitive peak isolation voltage	AC voltage (bipolar)	1414	V_{PK}
V_{IOWM}	Max. working isolation voltage	AC voltage; Time-dependent dielectric breakdown (TDDB) test	1000	V_{RMS}
		DC voltage	1414	V_{DC}
V_{IOTM}	Max. transient isolation voltage	$V_{TEST} = V_{IOTM}$, t = 60s (qualification); $V_{TEST} = 1.2 \times V_{IOTM}$, t = 1s (100% production)	7070	V_{PK}
V_{IOSM}	Max. surge isolation voltage	Test method per IEC 60065, 1.2/50 µs waveform, $V_{TEST} = 1.6 \times V_{IOSM}$ (qualification)	7070	V_{PK}
UL1577				
$V_{ISO(max)}$	Max. withstanding isolation voltage	$V_{TEST} = V_{ISO}$, t = 60s (qualification), $V_{TEST} = 1.2 \times V_{ISO}$, t = 1s (100% production)	5000	V_{RMS}

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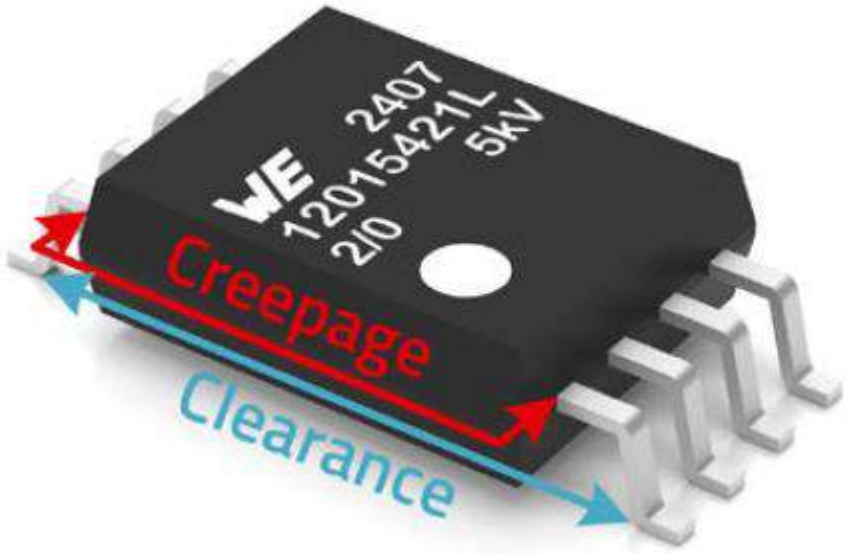
ADDITIONAL INFORMATION

Isolation

- **Clearance**
  - is the shortest distance through **air** between input and output terminals of an isolator.
- **Creepage**
  - is the shortest distance across the **surface** of the package between two conductive parts of an isolator.

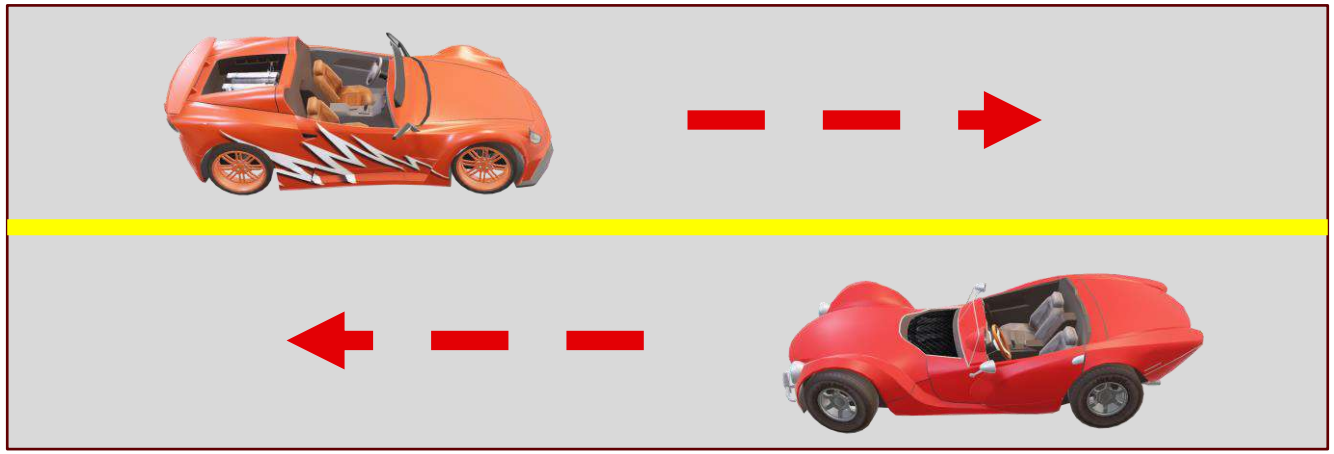


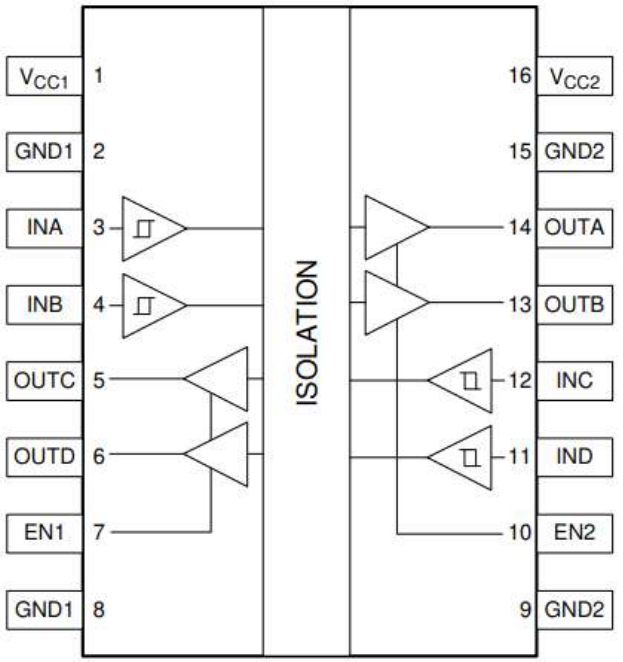
CHANNELS

Configurations

- **Direction**
  - 1/1, 2/0, 2/2, 3/1, 4/0 - No. of forward / No. of reverse

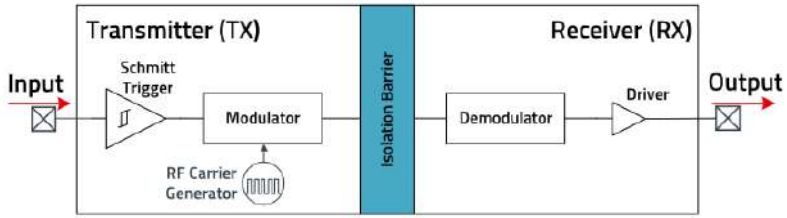
- **Number of channels**
  - 1/1, 2/0 = 2 channels
  - 2/2, 3/1, 4/0 = 4 channels





4 channels: 2/2 configuration

DEFAULT OUTPUTS

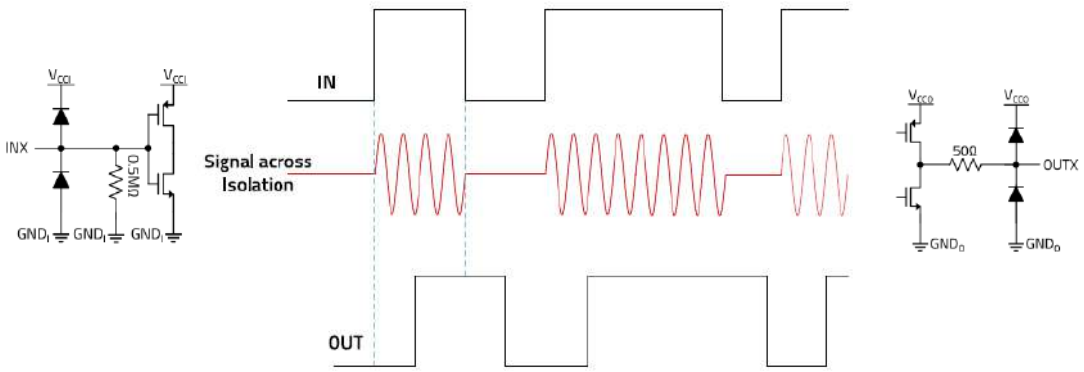


Function and Purpose

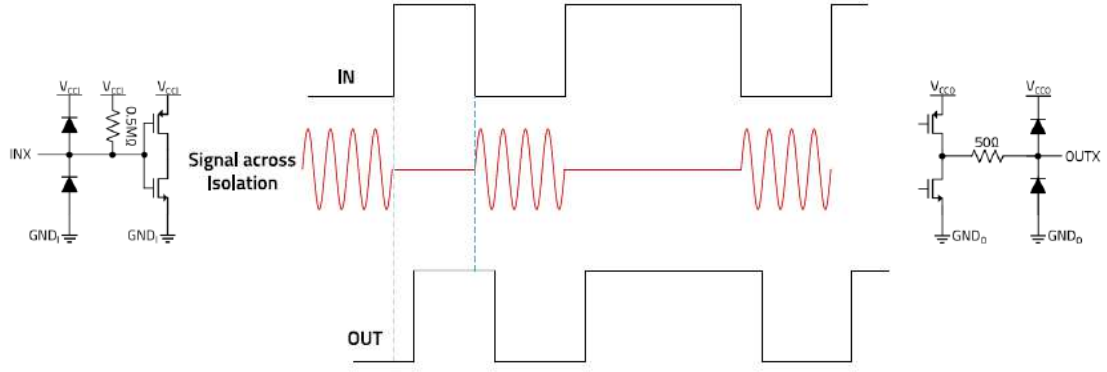
- is a predefined state of the output signal pin when the input side of the isolator is not powered, or the input signal pin is open/not connected.

- **Low** – are preferred for use in power supplies, like in SMPS, to isolate gate drivers for safety reasons.

- **High** – typically for communication interfaces, default high output is preferred as signal lines are defined as high logic level during idle/standby state.

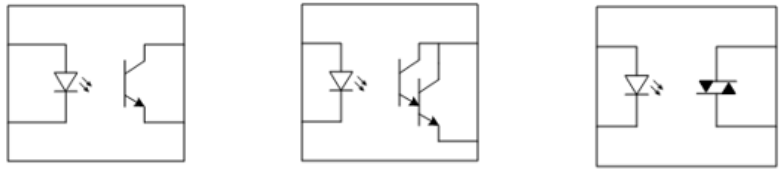


Default Low
Example: 18014015401**L**

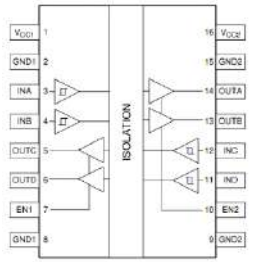


Default High
Example: 18014015401**H**

OPTOCOUPLERS VS. DIGITAL ISOLATORS



vs.



Pros	Cons
▪ Smaller size (for 1 channel) ▪ Cheaper	▪ More expensive




Cons	Pros
▪ Possible time degradation ▪ Lower stability over voltage and temperature	▪ Less external components ▪ Low power consumption ▪ More flexible channels options ▪ Smaller size (for multiple channels solution)

QUESTION #1

WE Digital Isolators are based on what technology?

a) Optical

b) Magnetic

c) Capacitive 

d) Radioactive

APPLICATIONS

Digital Isolator

APPLICATIONS

Typical Systems

- Electricity meters, grid
- Relay protection units
- Lighting
- Motors and drivers
- Power supply
- Medical equipment
- Test and measurements, data acquisition
- Industrial field (RS-485, CAN, SPI isolation)
- Green energy

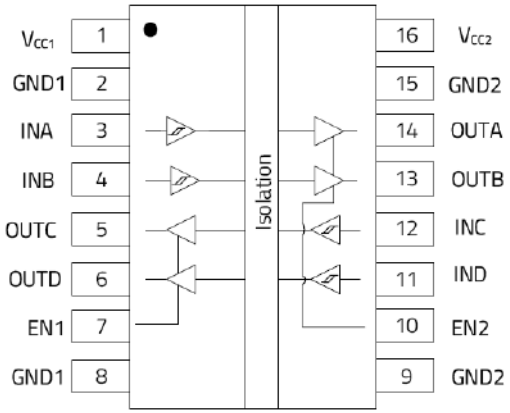
APPLICATIONS

Data interfaces

Protocol	Applications	Data Rate
RS-232	Modems, printers and PLC machines	up to 1 Mbps, but usually it is less than 500 kbps.
RS-422, RS-485	Industrial automation, smart meters, HVAC (Heating, Ventilation and Air Conditioning) systems, motor drives and tools	up to 10 Mbps
CAN	Industrial automation, automotive, transportation electronics, industrial control systems, building automation and HVAC systems.	up to 1 Mbps
CAN Flexible Data-Rate		in the range of 5 to 8 Mbps
I2C	Simple and low speed DAC/ADC, LCD or OLED displays, various types of sensors	up to 5 Mbps
SPI	Fast interface for communication between controllers, sensors and memory modules	up to 50 Mbps

MARKET TREND

Variants



Digital Isolators

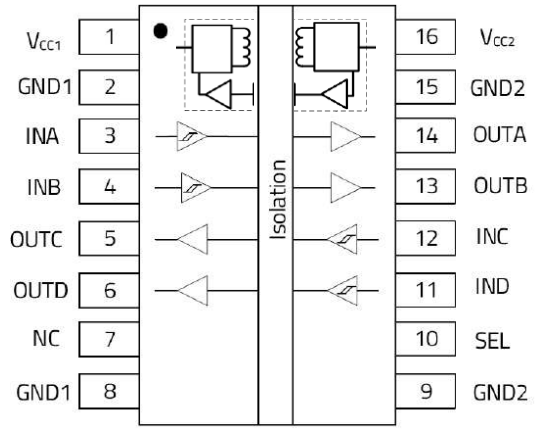
Isolation Voltage
2500V/3000V/3750V/5000V/5700V

Number of channels
1 ch/2 ch/3 ch/4 ch/5 ch/6 ch

Channels Configuration
4/0, 3/1, 2/2, 1/3, 0/4 (example for 4 ch DI)

Data Rate
1 Mbps - 150 Mbps

Package
SO-8 NB, SO-16 WB, SO-8 WB, SO-16 NB



Without integrated DC/DC converter

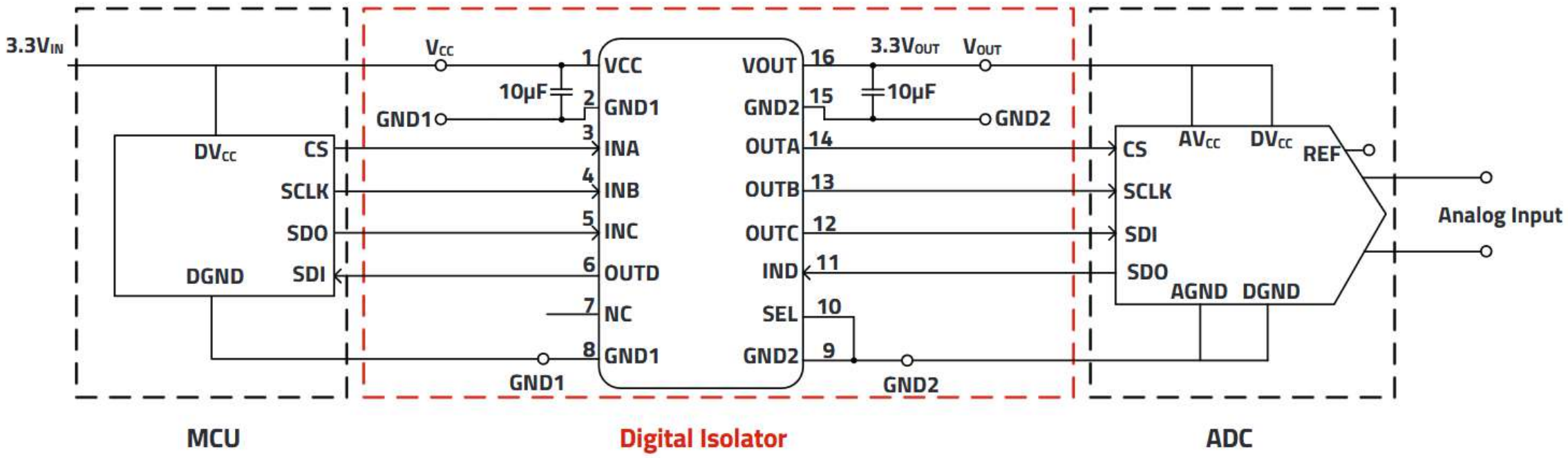
- Cheap
- Flexible
- The most common on the market

With integrated DC/DC converter

- Less space on PCB
- Easier to use

SAMPLE SCHEMATIC

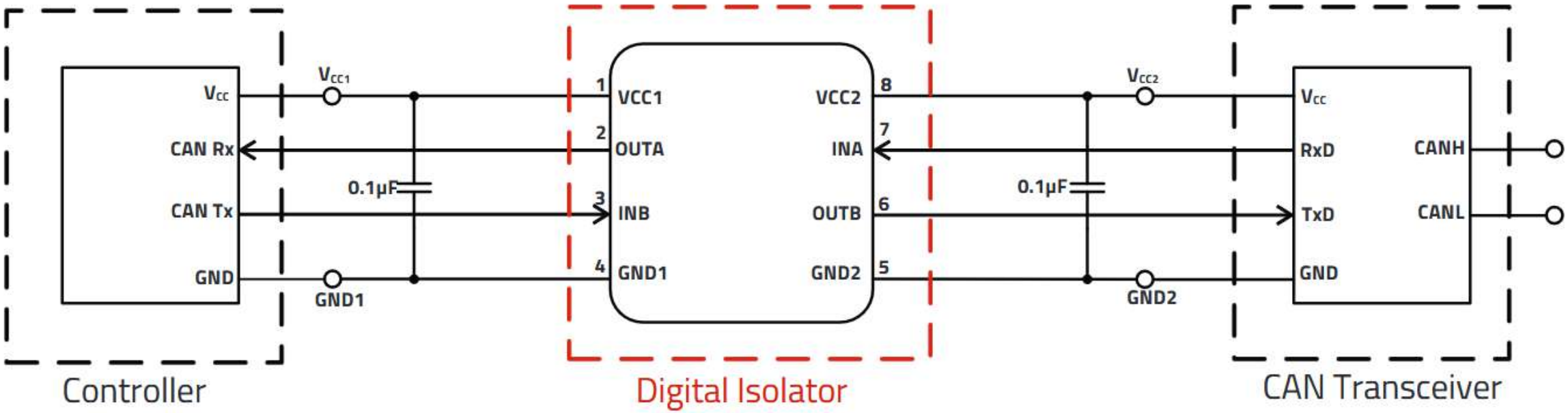
SPI and ADC



Recommended part number: 18024115401H (SOIC-16WB)

SAMPLE SCHEMATIC

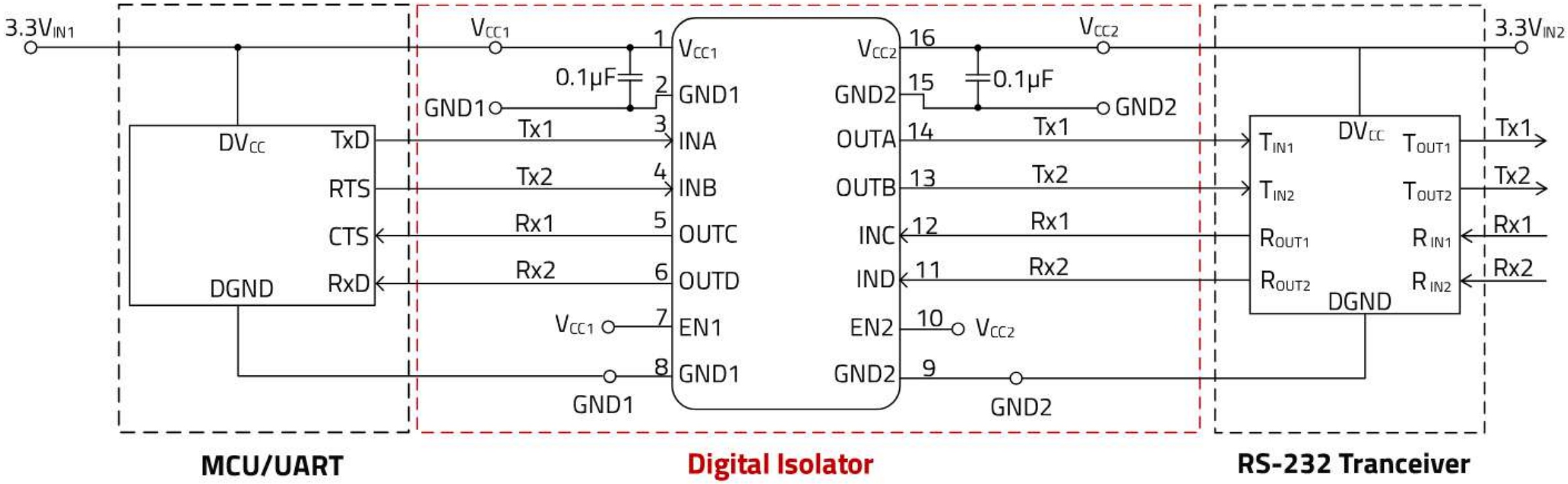
Controlled Area Network (CAN)



Recommended part numbers: 18012115411H (SOIC-8NB) or 18012115421H (SOIC-8WB)

SAMPLE SCHEMATIC

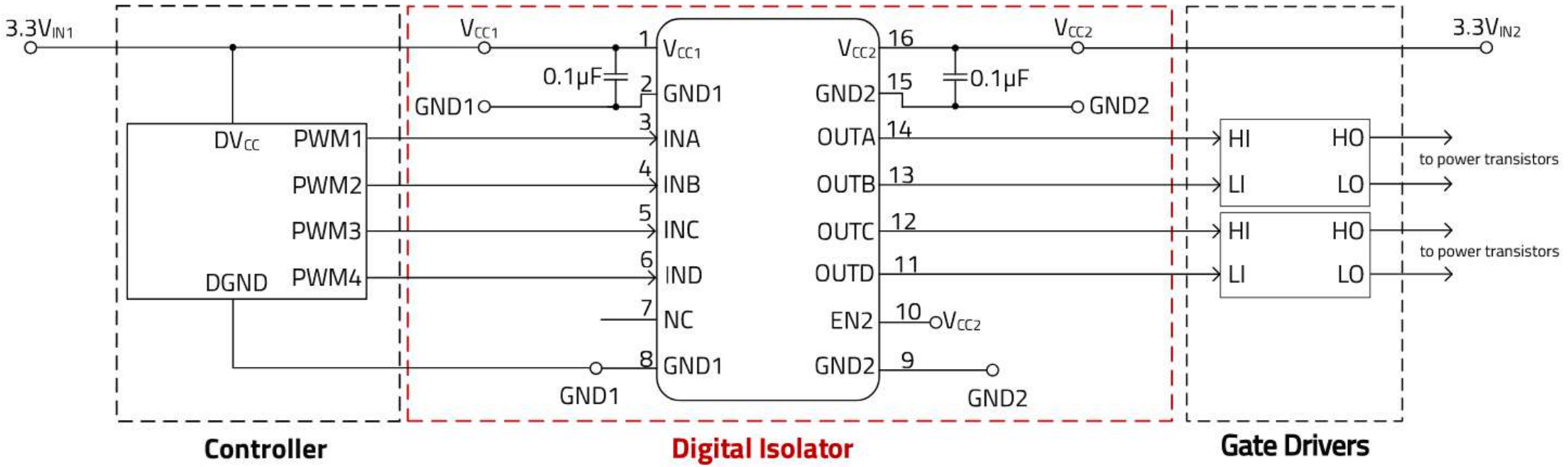
RS-232



Recommended part number(s): 18014215401H

SAMPLE SCHEMATIC

Gate Drivers

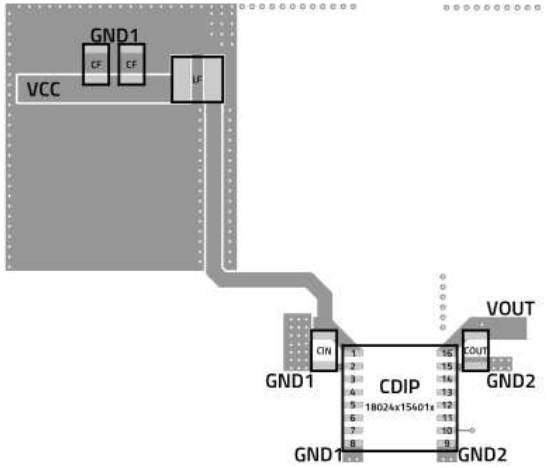


Recommended part number(s): 18012015421L, 18014015401L

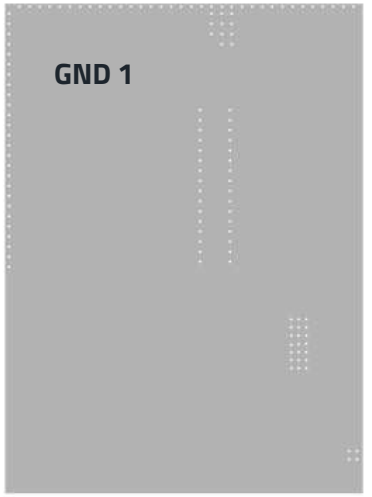
PCB DESIGN

General Guidelines

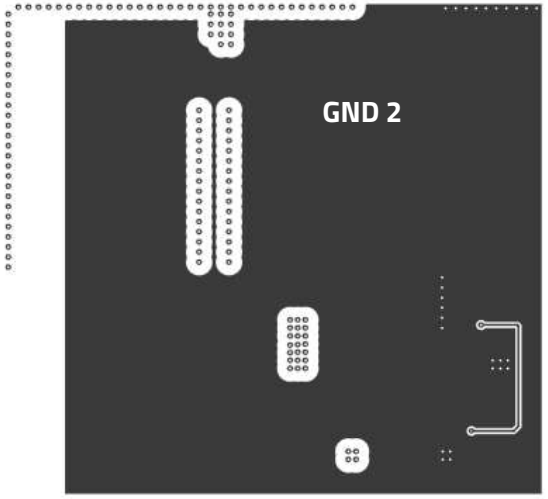
- Signal traces should be impedance matched to 50Ω, especially if the trace length exceeds λ*1/16.
- A reference GND should always be placed below any signal traces.
- The input and output capacitors should be placed as close to the VCC and VOUT pins as possible.
- Any feature traces, such as SEL, should be routed between layers 2 and 4 to avoid interrupting signal references.
- Avoid sharp corners when routing signal traces.



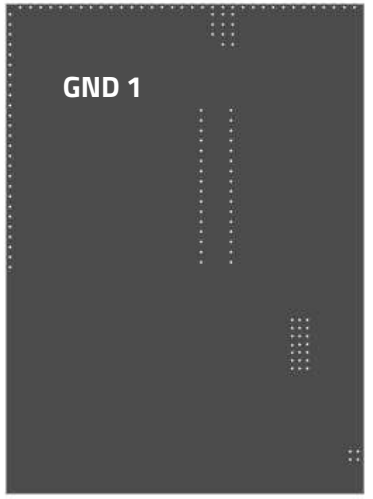
Top Layer



Second Layer



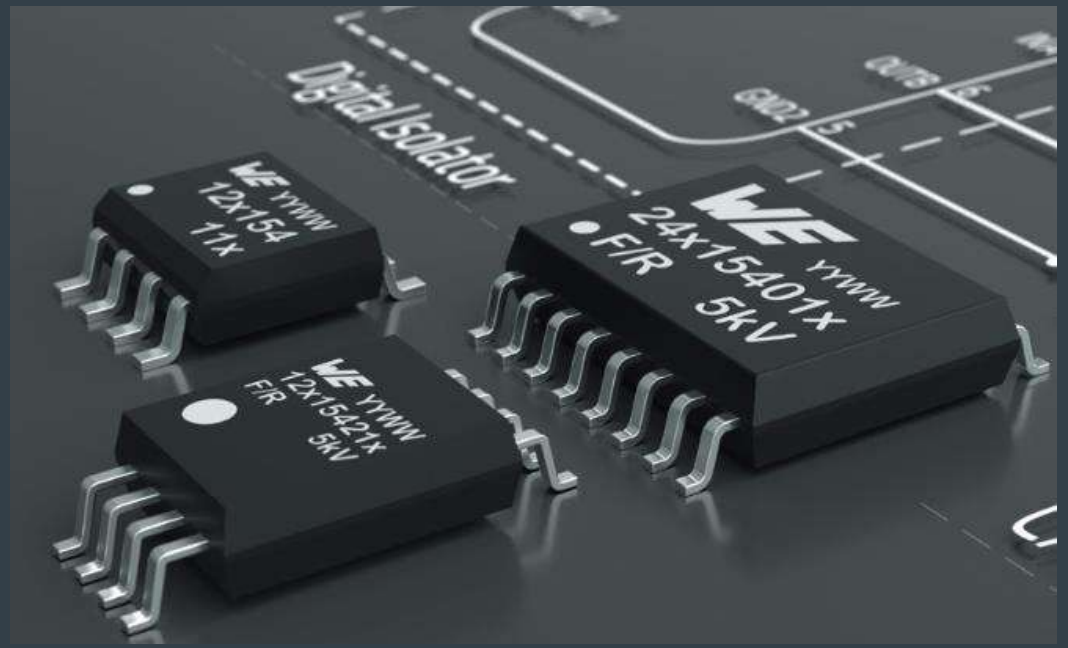
Third Layer



Bottom Layer

WE PORTFOLIO

Digital Isolator



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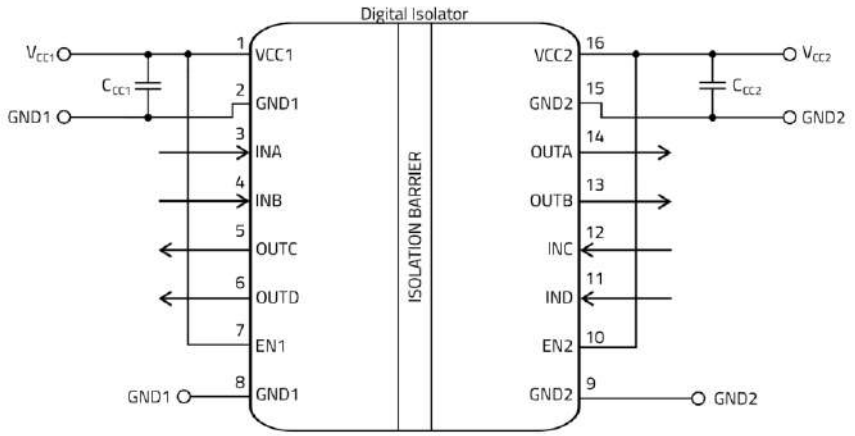
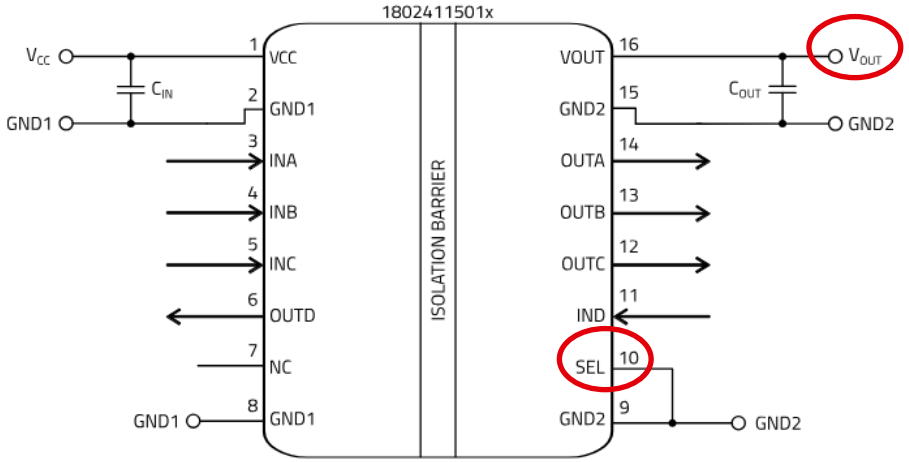
WE PORTFOLIO

Product Overview



Digital Isolators



without integrated power

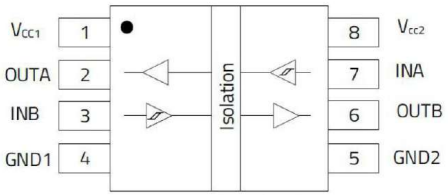
with integrated power

WE PORTFOLIO

20 part numbers are now available

2 channel unpowered

WPME-CDIS

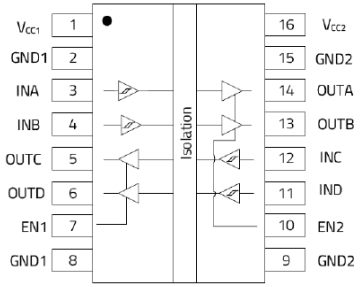


- Isolation Voltage: **3,750 V**
- Channels configuration: **2/0** and **1/1**
- Default output **high** and **low**
- Data Rate: **150 Mbps**
- Package: **SO-8 NB**

18012115421L 18012115421H
18012015411H 18012015421H
18012115411H 18012115411L
18012015421L 18012015411L

4 channel unpowered

WPME-CDIS

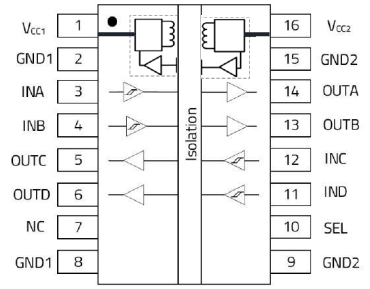


- Isolation Voltage: **5,000 V**
- Channels configuration: **4/0, 3/1, 2/2**
- Default output **high** and **low**
- Data Rate: **150 Mbps**
- Package: **SO-16 WB**

18014015401H
18014215401H
18014115401H
18014215401L
18014015401L
18014115401L

4 channel powered

WPME-CDIP



- Isolation Voltage: **5,000 V**
- Channels configuration: **4/0, 3/1, 2/2**
- Default output **high** and **low**
- Data Rate: **100 Mbps**
- Package: **SO-16 WB**

18024115401L
18024215401L
18024115401H
18024215401H
18024015401H
18024015401L

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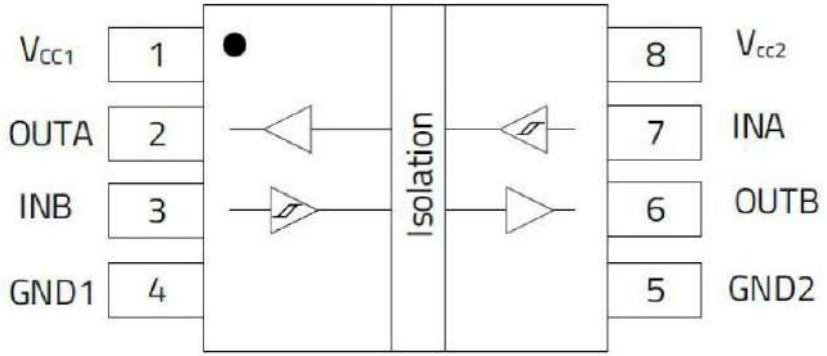
WE PORTFOLIO

WITHOUT Integrated Power – 2 Channels

- **2** channels configuration: **2/0** and **1/1**
- Isolation Voltage: **3750 V** (for 60 sec.)
- Surge voltage: **10 kV**
- CMTI: **100 (kV/µs)**
- Propagation delay: **5-15 ns**
- Data Rate: **150 Mbps**
- Channels Default output **high** and **low**
- Package: **SO-8 NB**

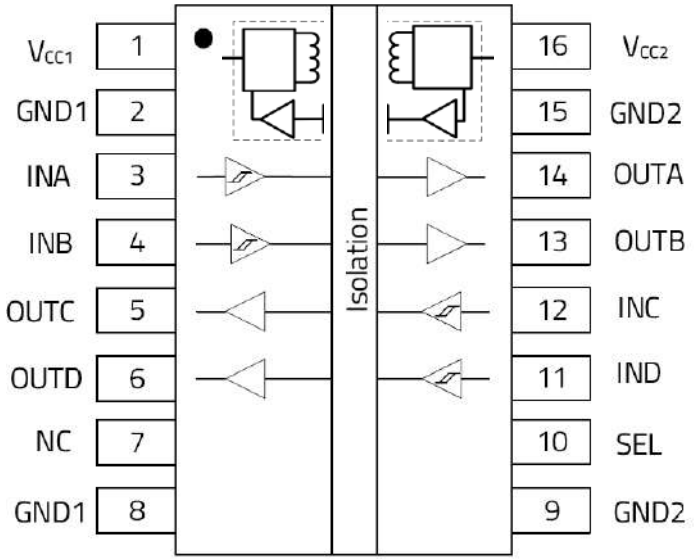


2 channels: 1/1 configuration

WE PORTFOLIO

WITHOUT Integrated Power – 4 Channels

- **4** channels configuration: **4/0, 3/1** and **2/2**
- Isolation Voltage: **5000 V** (for 60 sec.)
- Surge voltage: **10 kV**
- CMTI: **150 (kV/µs)**
- Propagation delay: **5-16 ns**
- Data Rate: **150 Mbps**
- Channels Default output **high** and **low**
- Package: **SO-16 WB**

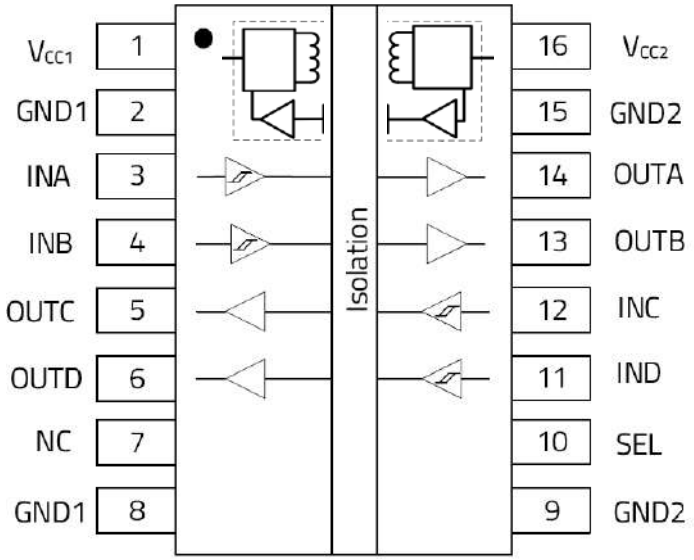


4 channels: 2/2 configuration

WE PORTFOLIO

WITH Integrated Power – 4 Channels

- **4** channels configuration: **4/0, 3/1** and **2/2**
- Isolation Voltage: **5000 V** (for 60 sec.)
- Surge voltage: **10 kV**
- CMTI: **150 (kV/µs)**
- Propagation delay: **10-20 ns**
- Data Rate: **100 Mbps**
- Channels Default output **high** and **low**
- Package: **SO-16 WB**
- **Not** pin-to-pin to isolators without integrated power

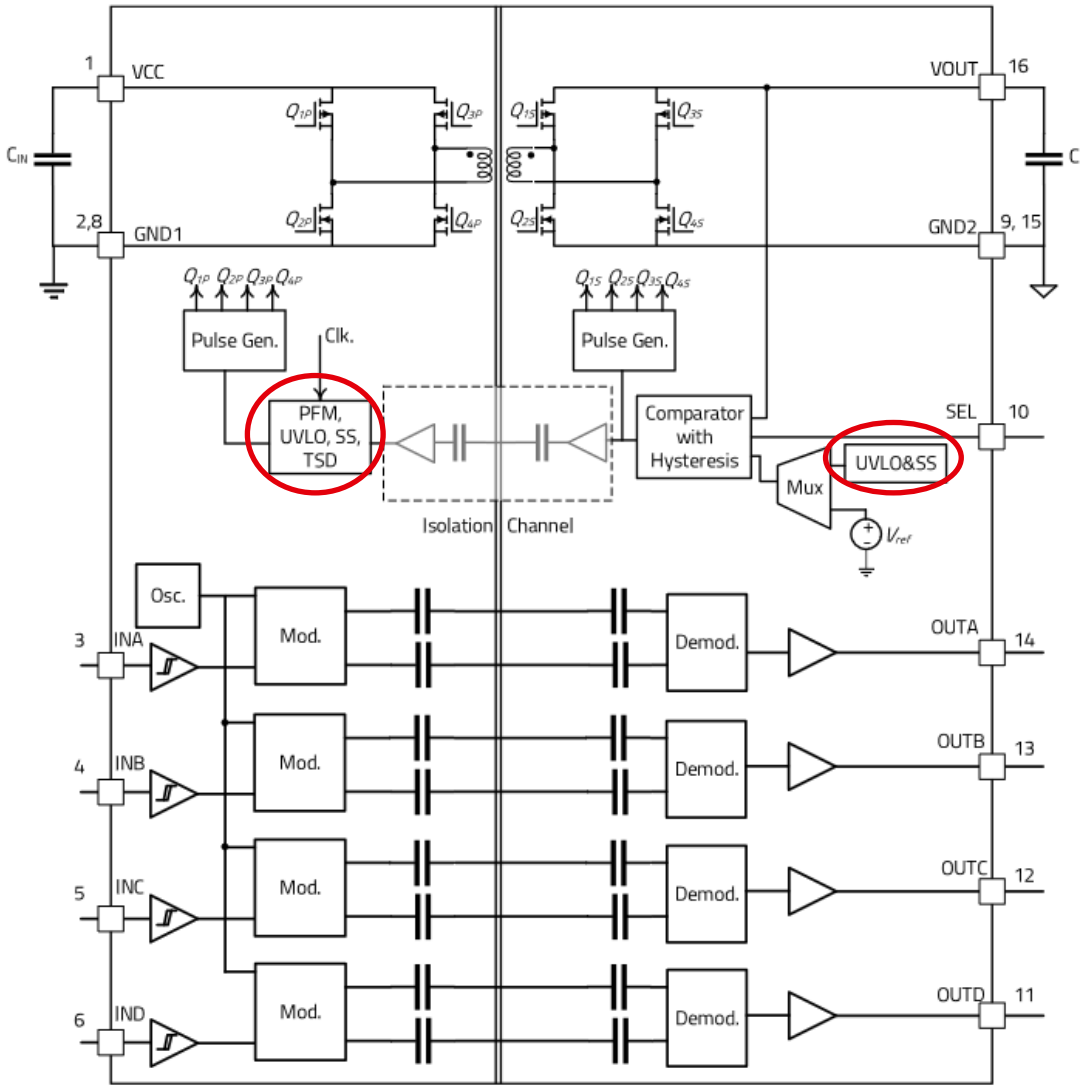


4 channels: 2/2 configuration

MORE THAN YOU EXPECT

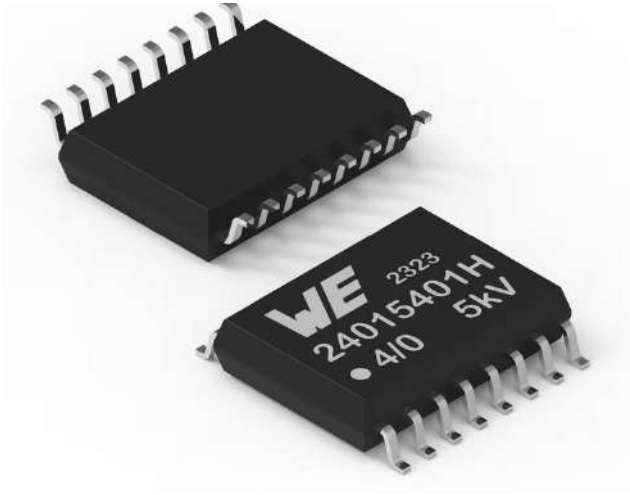
WE Protection Features

- **Soft-Start**
  - When the input and output voltages reach the UVLO rising threshold (typ. 2.75V), then the component operates.
- **Over Temperature Protection (OTP)**
  - an internal thermal shutdown circuit, which activates when the junction temperature reaches 180 °C (typ).
- **Over Current Protection (OCP) / Short Circuit Protection (SCP)**
  - The output voltage is continuously monitored and when it drops below a certain threshold, the controller stops switching.
- **Input/Output Undervoltage Lockout (UVLO)**
  - The device incorporates input and output undervoltage lockout (UVLO) to protect from unexpected behavior at input voltages below the recommended values.



WE PORTFOLIO

Component Marking



MARKING	DESCRIPTION
WE	Würth Elektronik eiSos GmbH & Co. KG
YYWW	Year and calendar week
14x15401x	Order code
F/R	Number of forward/reverse channels
5kV	5kV isolation voltage

QUESTION #2

What are the features of WE Digital Isolators?

a) Standard IC packaging sizes.

b) With and without integrated power.

c) Up to 150 Mbps data rate.

d) High or low default output.

e) UVLO, OCP, OTP, and Soft-start.

f) Approvals on safety standards.

g) All of the above. 

WE SUPPORT

Digital Isolator

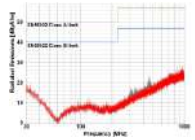
REDEXPERT®

WE SUPPORT

Benefits

Simple Design-In
→ “Me too” product

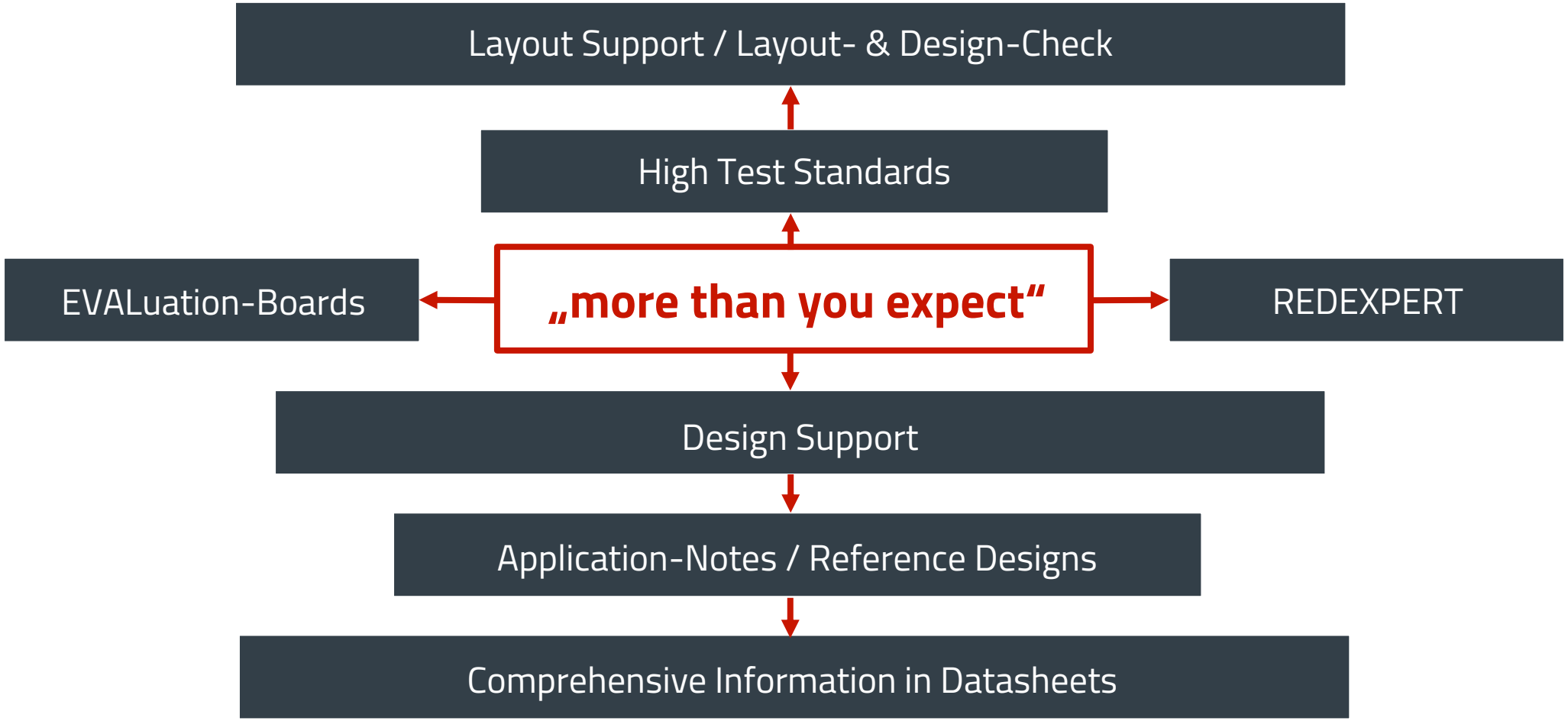
Competitive price, stock and forecasting



Options with and without integrated power; high and low default output state

Technical support

WE SUPPORT

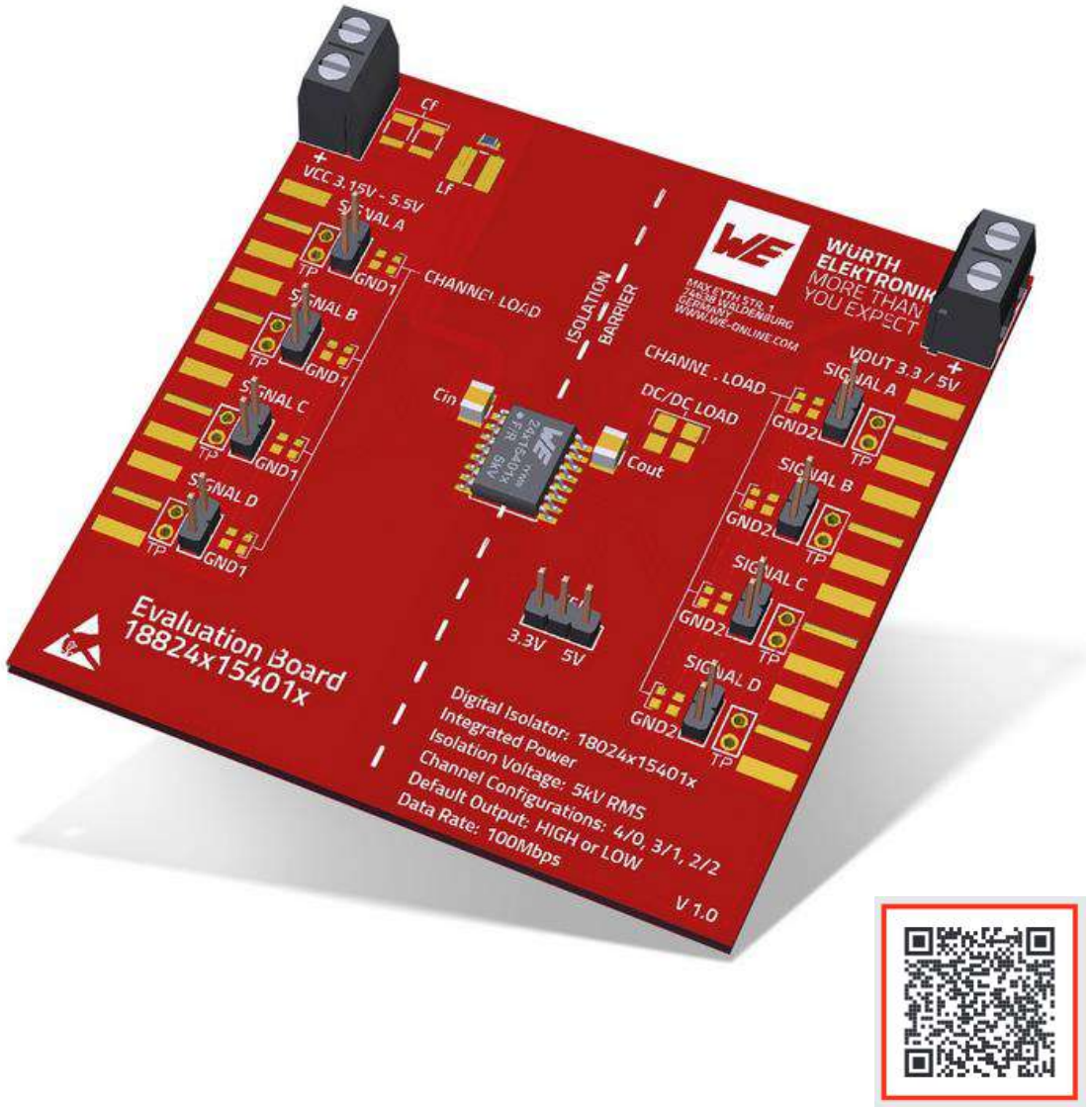

Layout Support / Layout- & Design-Check
High Test Standards
EVALuation-Boards
„more than you expect“
REDEXPERT
Design Support
Application-Notes / Reference Designs
Comprehensive Information in Datasheets

DESIGN SUPPORT

Samples / Evaluation Kits

- For customers we provide samples and evaluation boards.

- There is an evaluation board for every isolator with integrated power and bulk evaluation board without soldered isolator for unpowered Digital Isolator.



DESIGN SUPPORT

Component files

	Order Code	Data-sheet	Simu-lation	Downloads	Status	$V_{CC\ min.}$ (V)	$V_{CC\ max.}$	Channel Configuration	t_{PLH}, t_{PHL} (ns)	DR (Mbps)
	18024015401H	SPEC	RE	10 FILES	Active	3.15	5.5	4/0	10	100
	18024015401L	SPEC	RE							00
	18024115401H	SPEC	RE							00
	18024115401L	SPEC	RE							00
	18024215401H	SPEC	RE							00
	18024215401L	SPEC	RE							00

EDA models: Components ZIP

- ALT Altium_WPME-CDIP (rev24a).IntLib | 182.5 KB
- CDS Cadence_WPME-CDIP (rev24a).zip | 592.7 KB
- EAG Eagle_WPME-CDIP (rev23a).lbr | 38.7 KB

CAD files ZIP

- 3D 3D_CDIP_18024x15401x (rev1).pdf | 301.2 KB
- IGS IGS_CDIP_18024x15401x (rev1).igs | 3 MB
- STP STP_CDIP_18024x15401x (rev1).stp | 898 KB

Others ZIP

- PDF Wuerth_Digital_Isolators_VDE_Appendix_500Z1_(Reinforced_SOIC-8WB_SOIC-16WB) (rev1).pdf | 51.7 KB

Download all 10 files as zip archive ZIP

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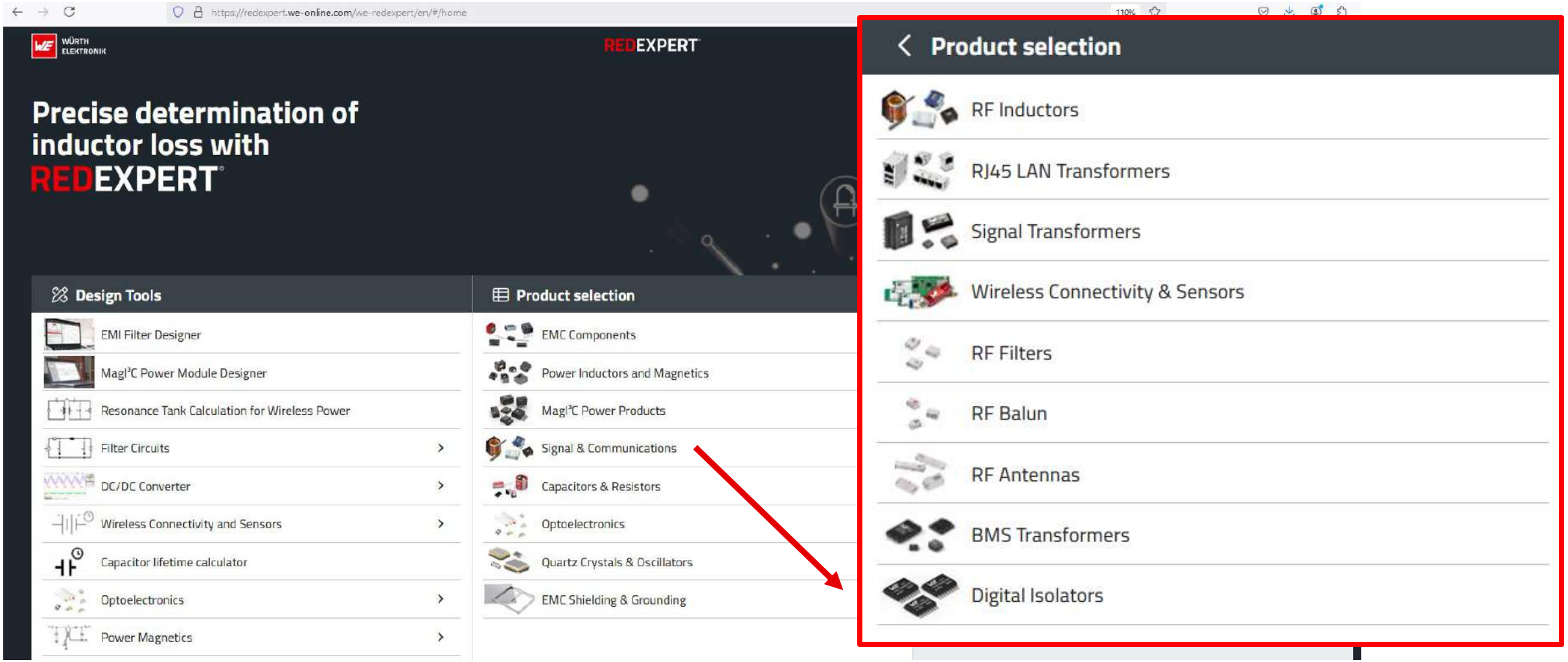
Component selection and simulation tool.



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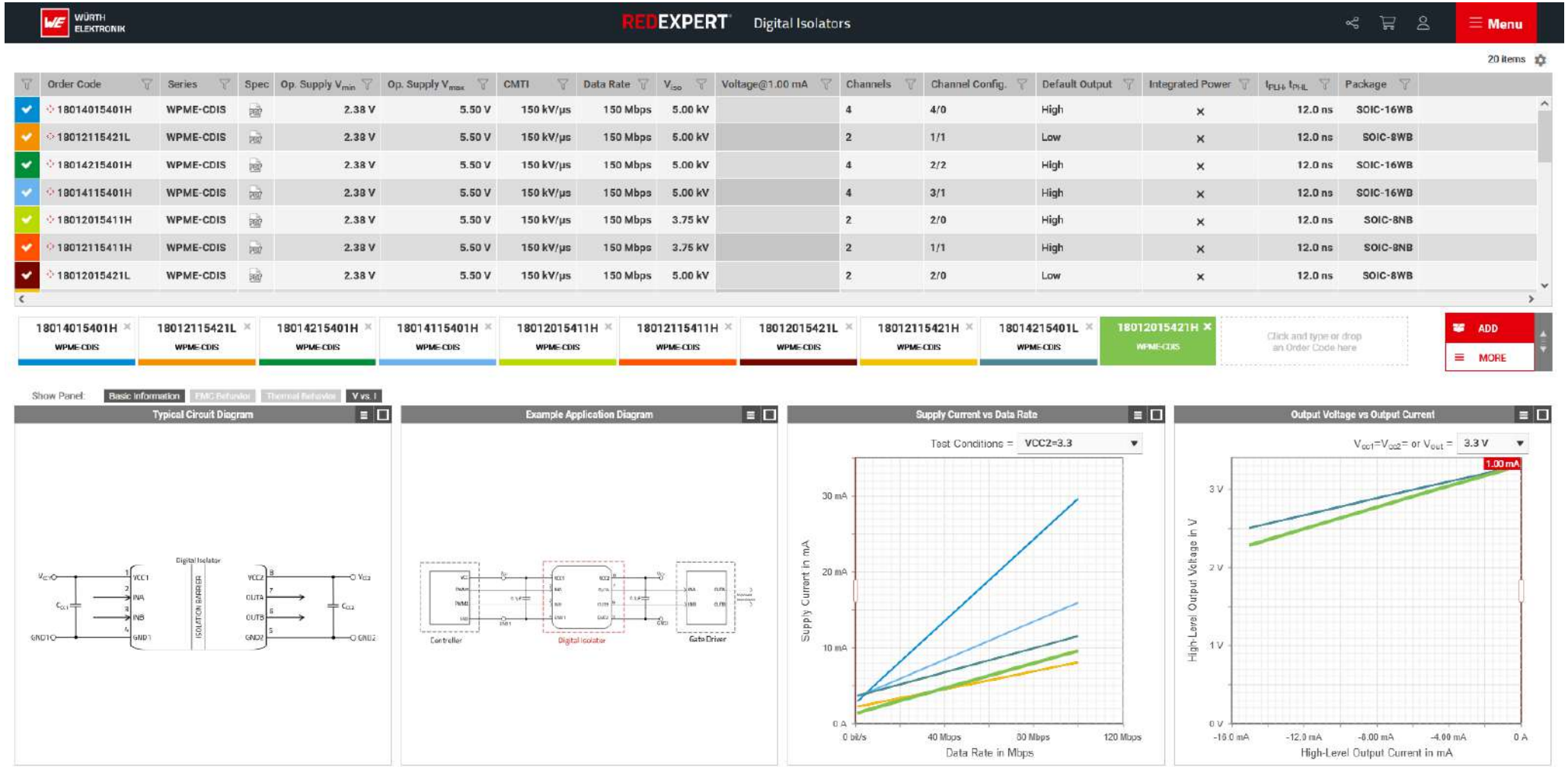
Component selection and simulation tool.



QUESTION #3

What are the WE support advantages?

a) REDEXPERT – component selection and simulation tool.

b) Downloadable component libraries.

c) Design and technical support.

d) Application notes and reference designs.

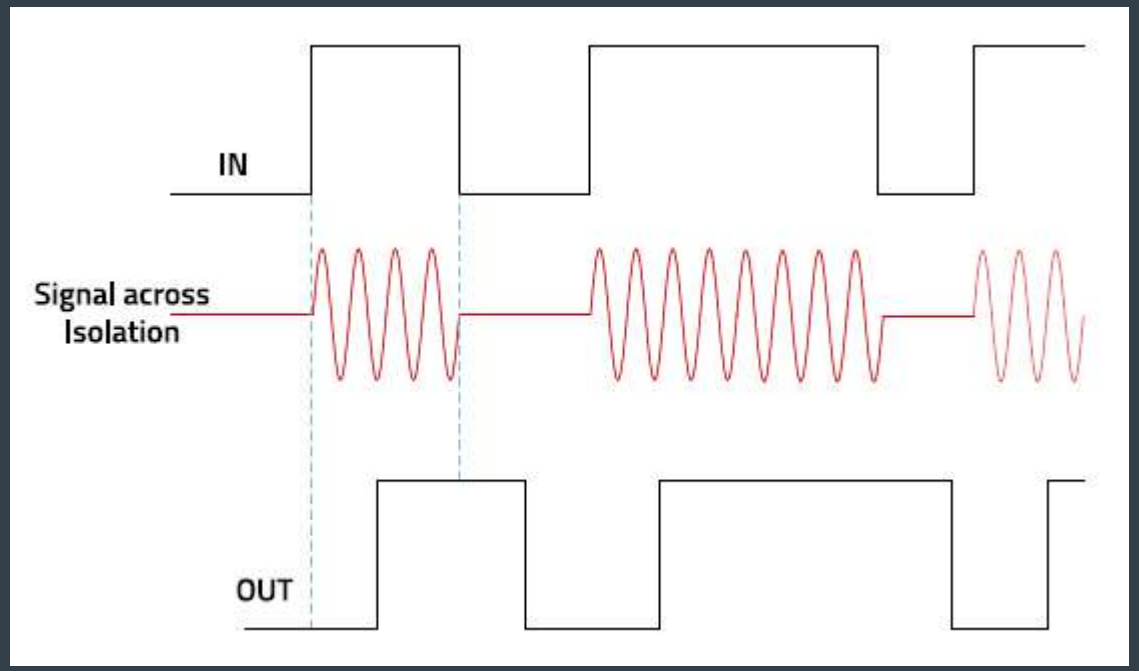
e) Evaluation kits and free samples.

f) Competitive pricing, and stocks availability.

g) All of the above ✓

DEMO

Digital Isolator



DIGITAL ISOLATOR DEMO

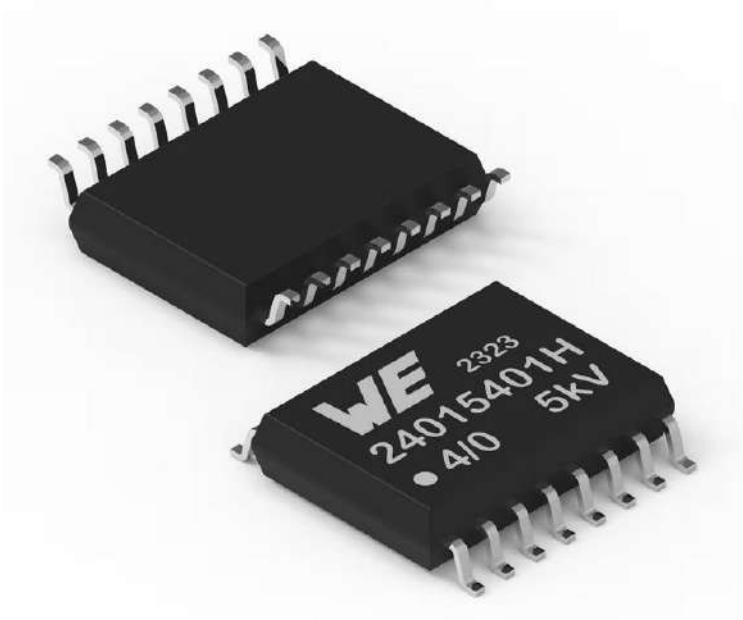
Contents

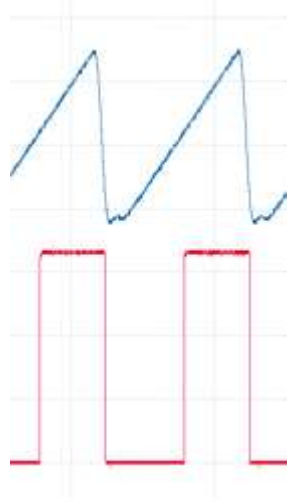
- Materials and tools
- Test setup
- Measurements

** Some presentation images have clickable web links*

MATERIALS AND TOOLS

- Digital Isolator Evaluation Kit – WE PN: 18824215401L
- Signal Generator
- Oscilloscope
- Multimeter

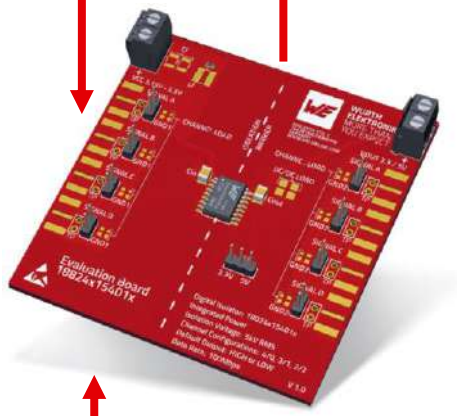




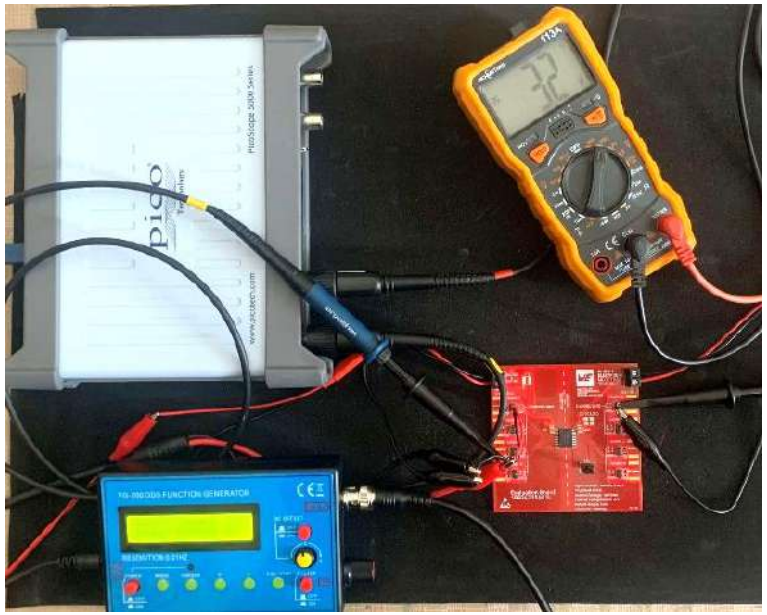
TEST SETUP

Computer

Oscilloscope + a) Signal Generator



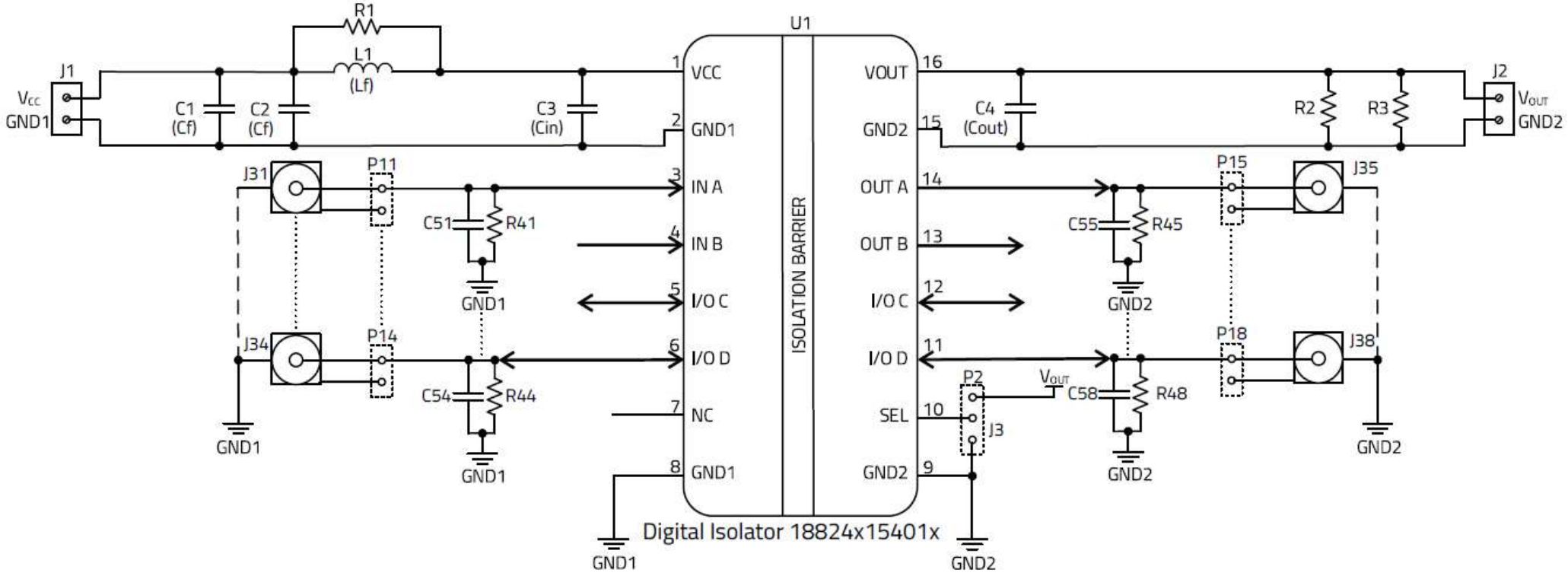
Digital Isolator EV Kit



or b) Signal Generator

EVALUATION KIT

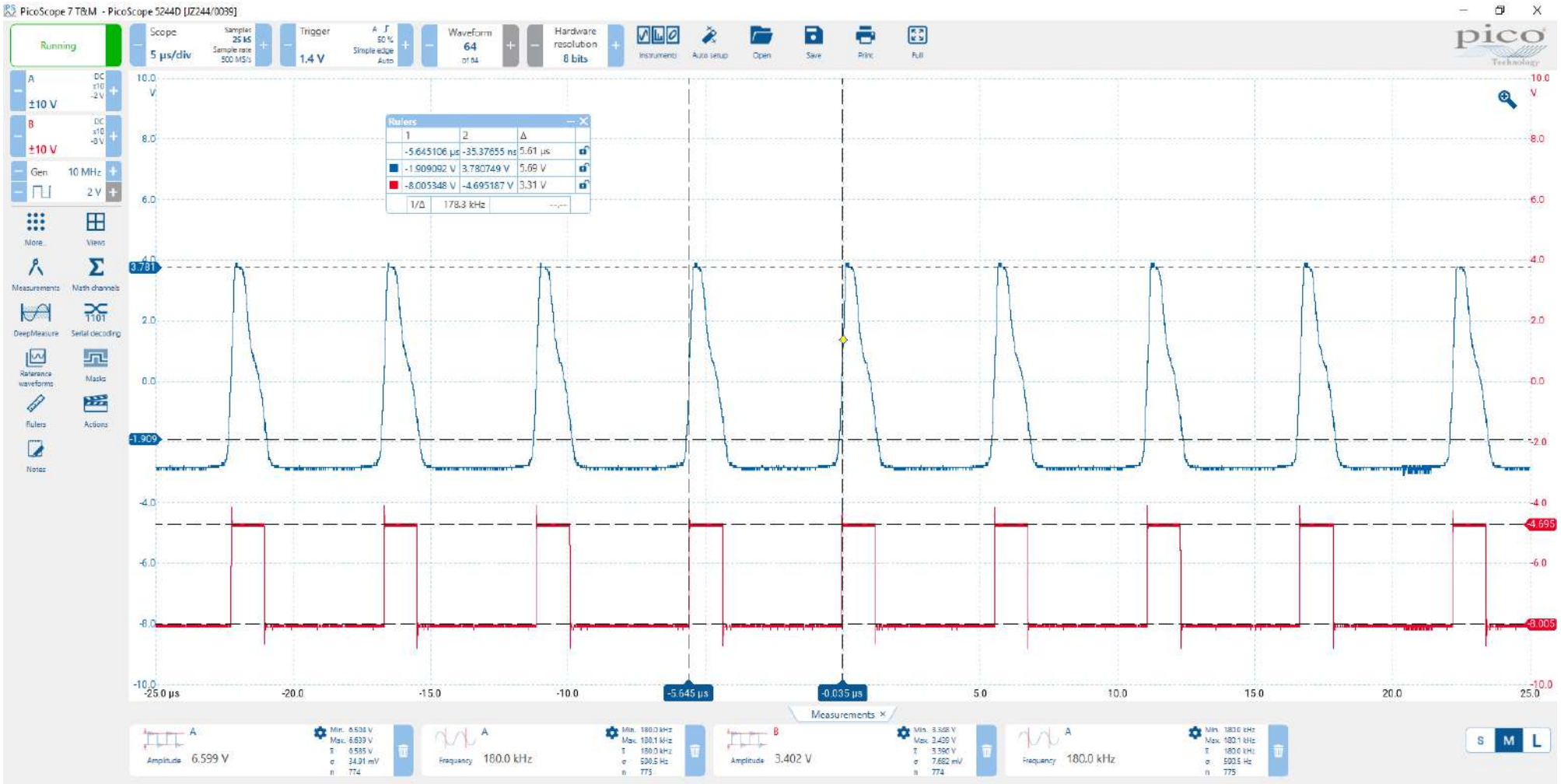
Schematic



MEASUREMENTS

Input Output

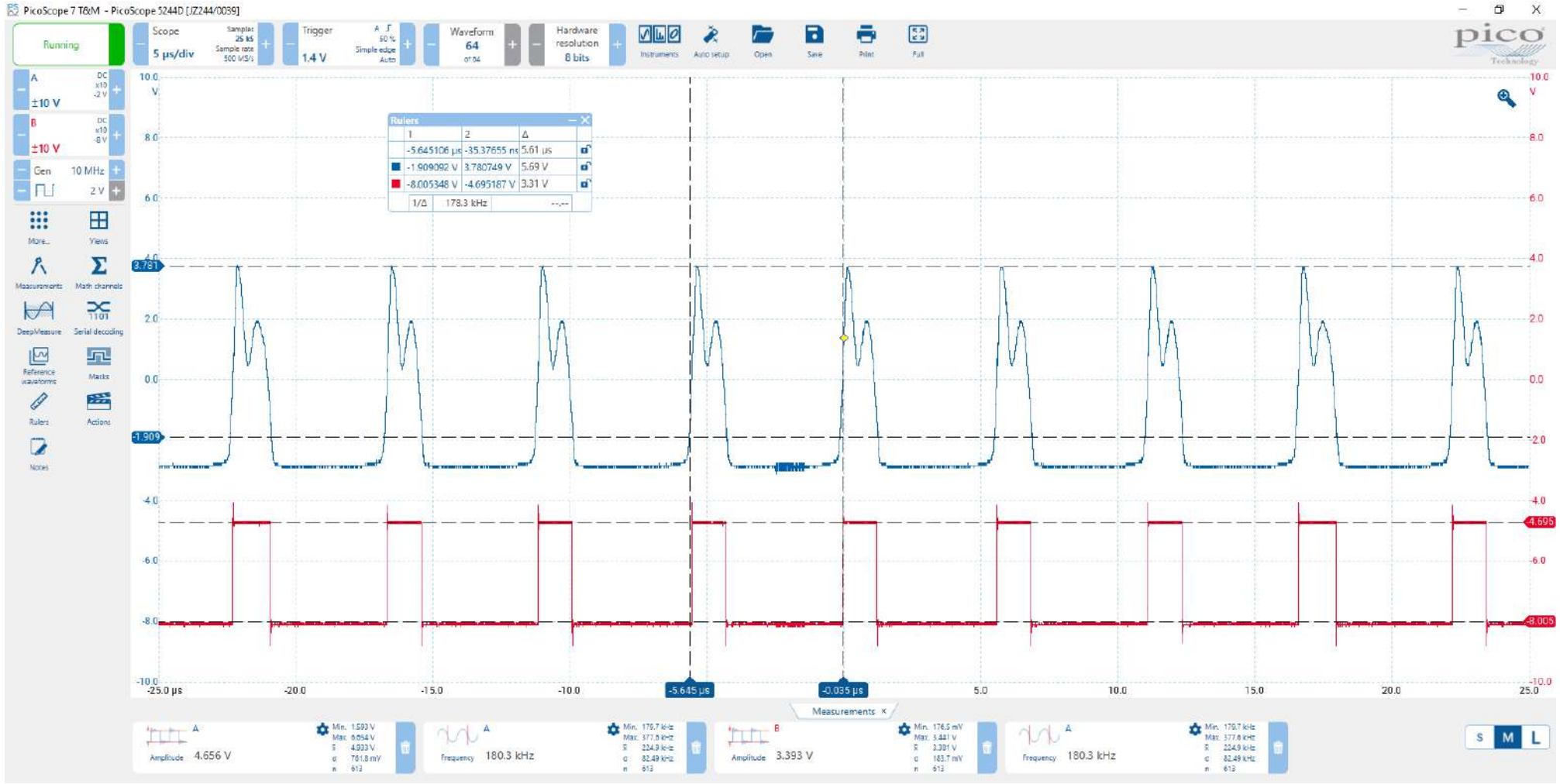
With Gaussian input



MEASUREMENTS

Input Output

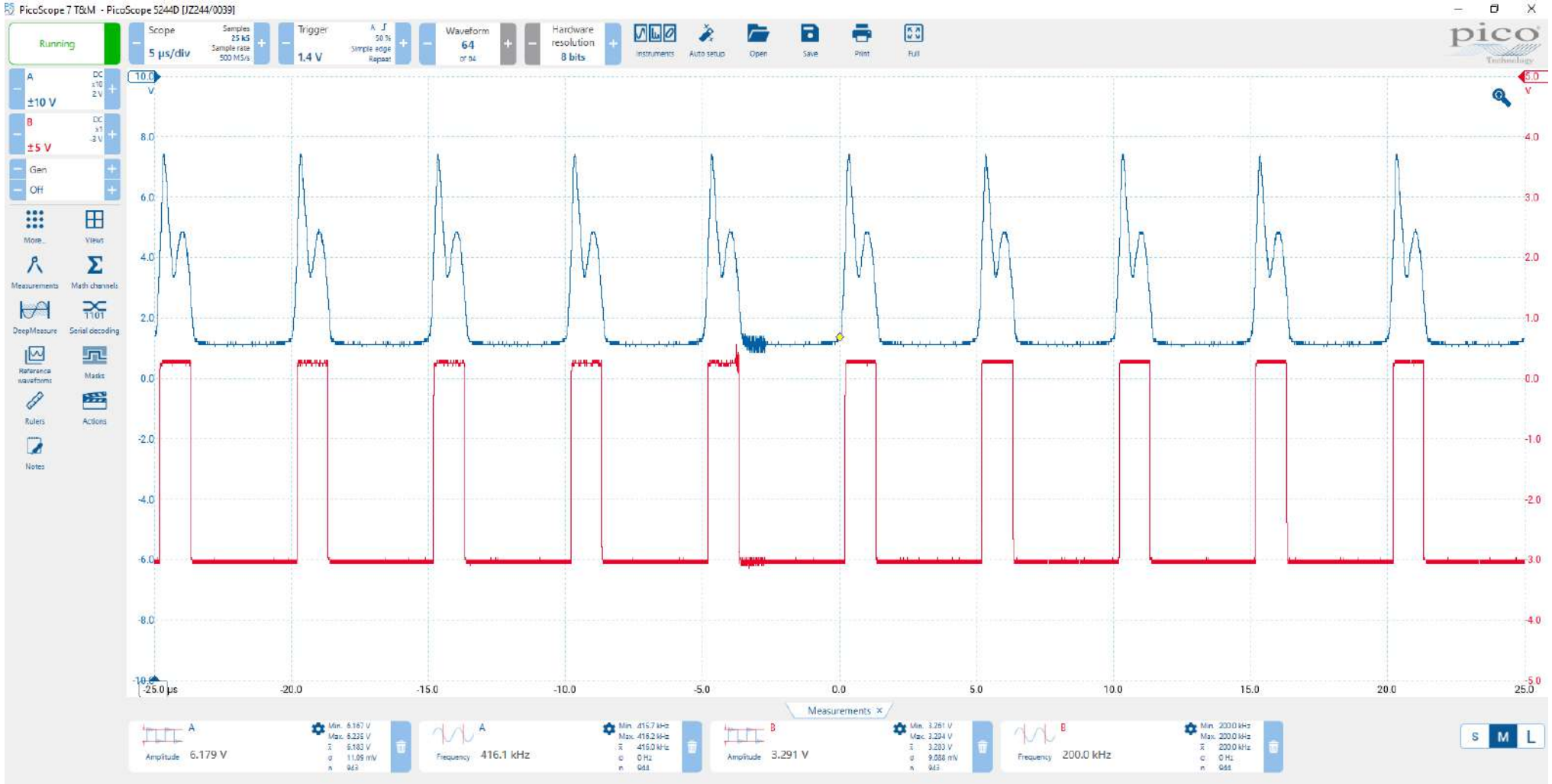
With noisy square wave input



MEASUREMENTS

Input Output

With noisy square wave input



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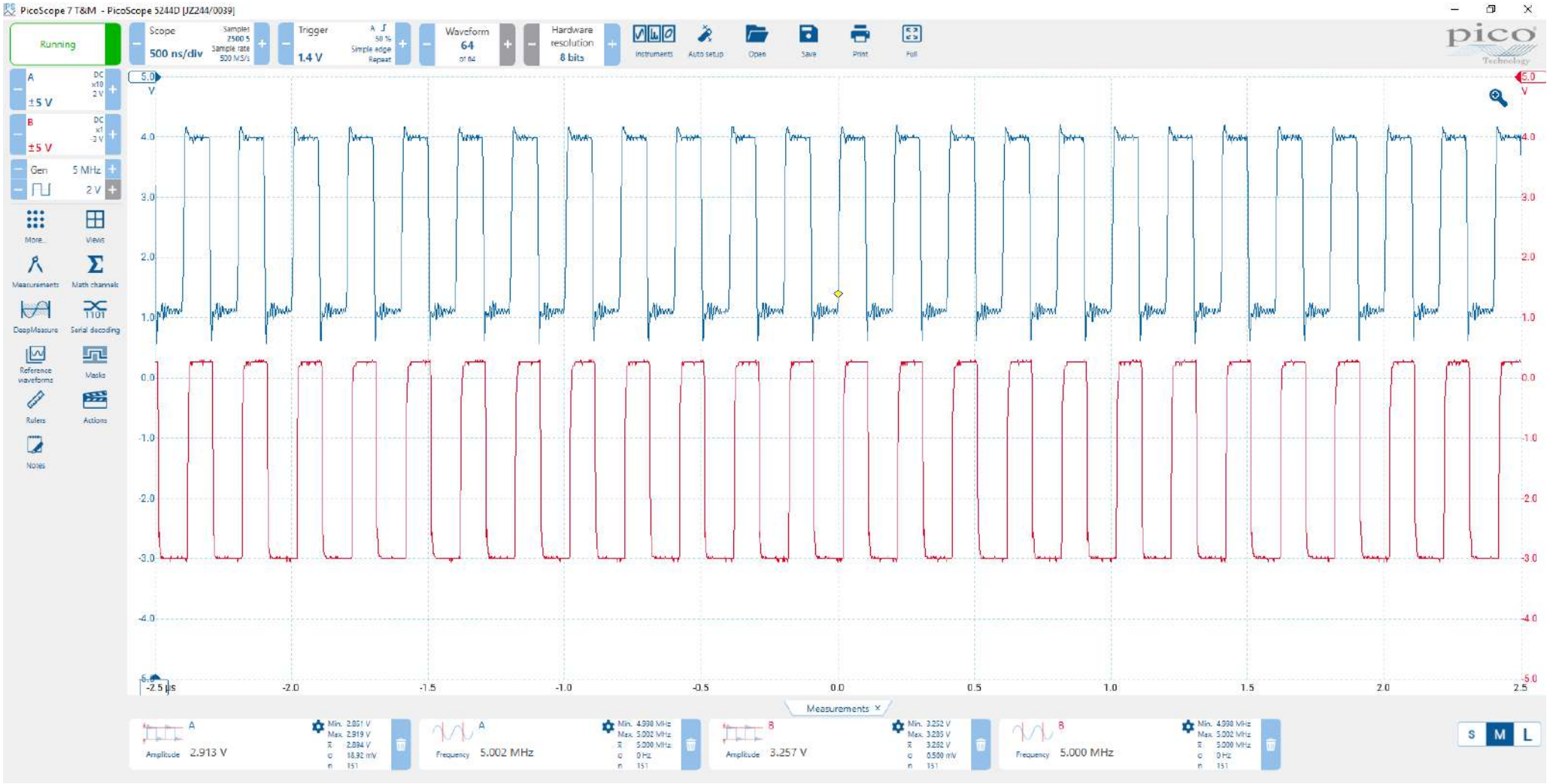
MEASUREMENTS

Input Output

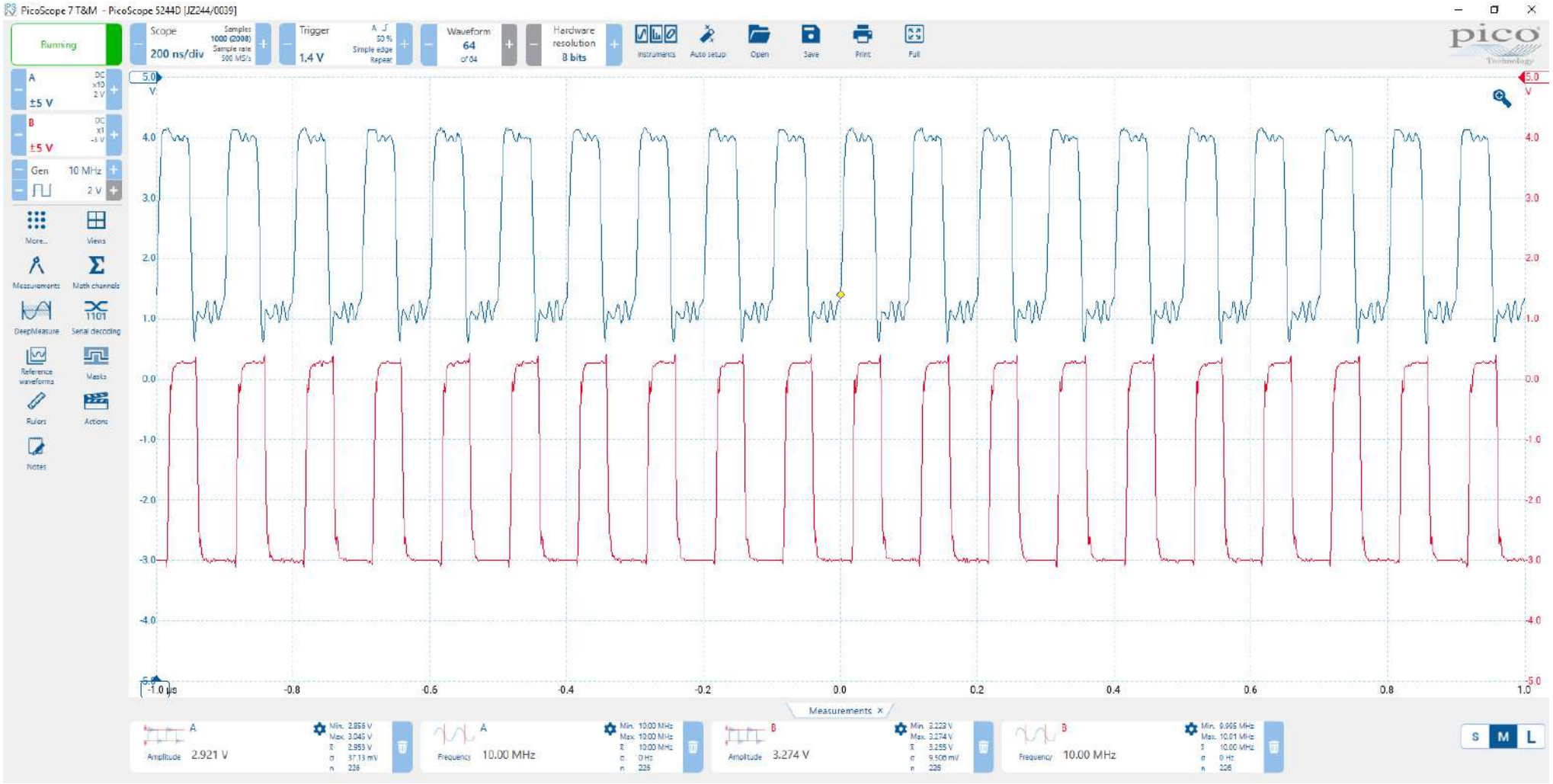
With noisy square wave input



MEASUREMENTS

Input Output

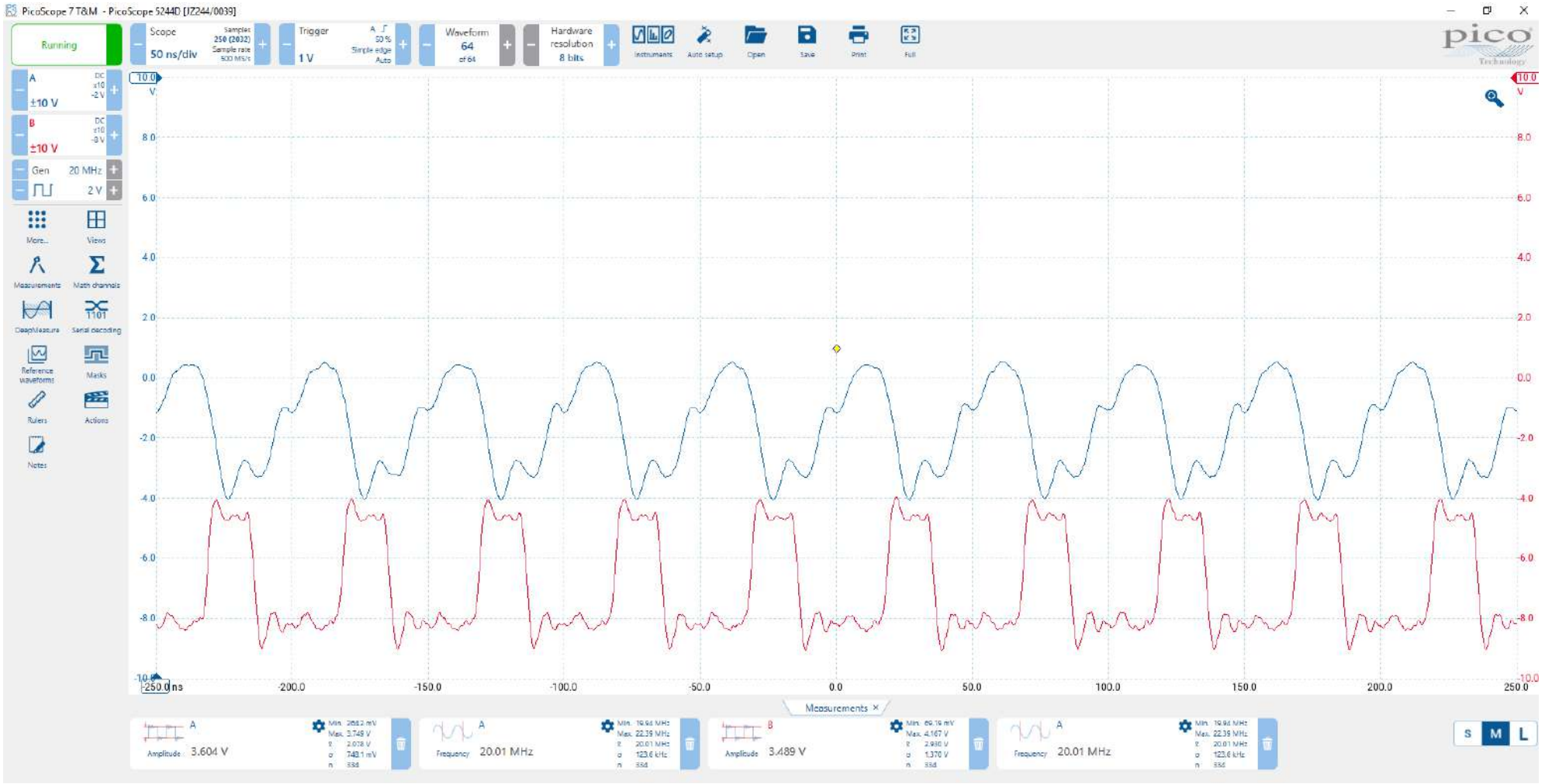
With noisy square wave input



MEASUREMENTS

Input Output

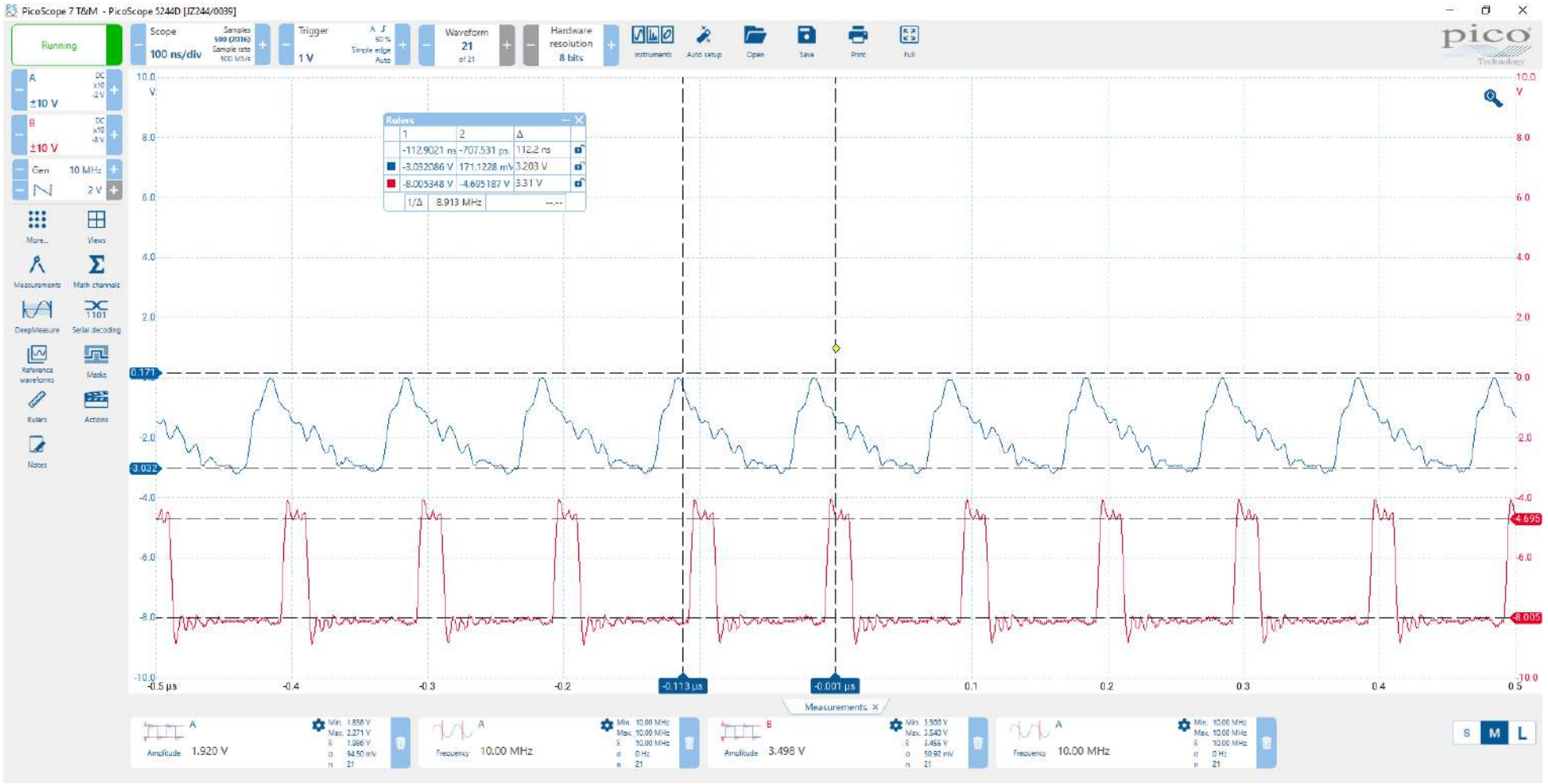
With noisy square wave input



MEASUREMENTS

Input Output

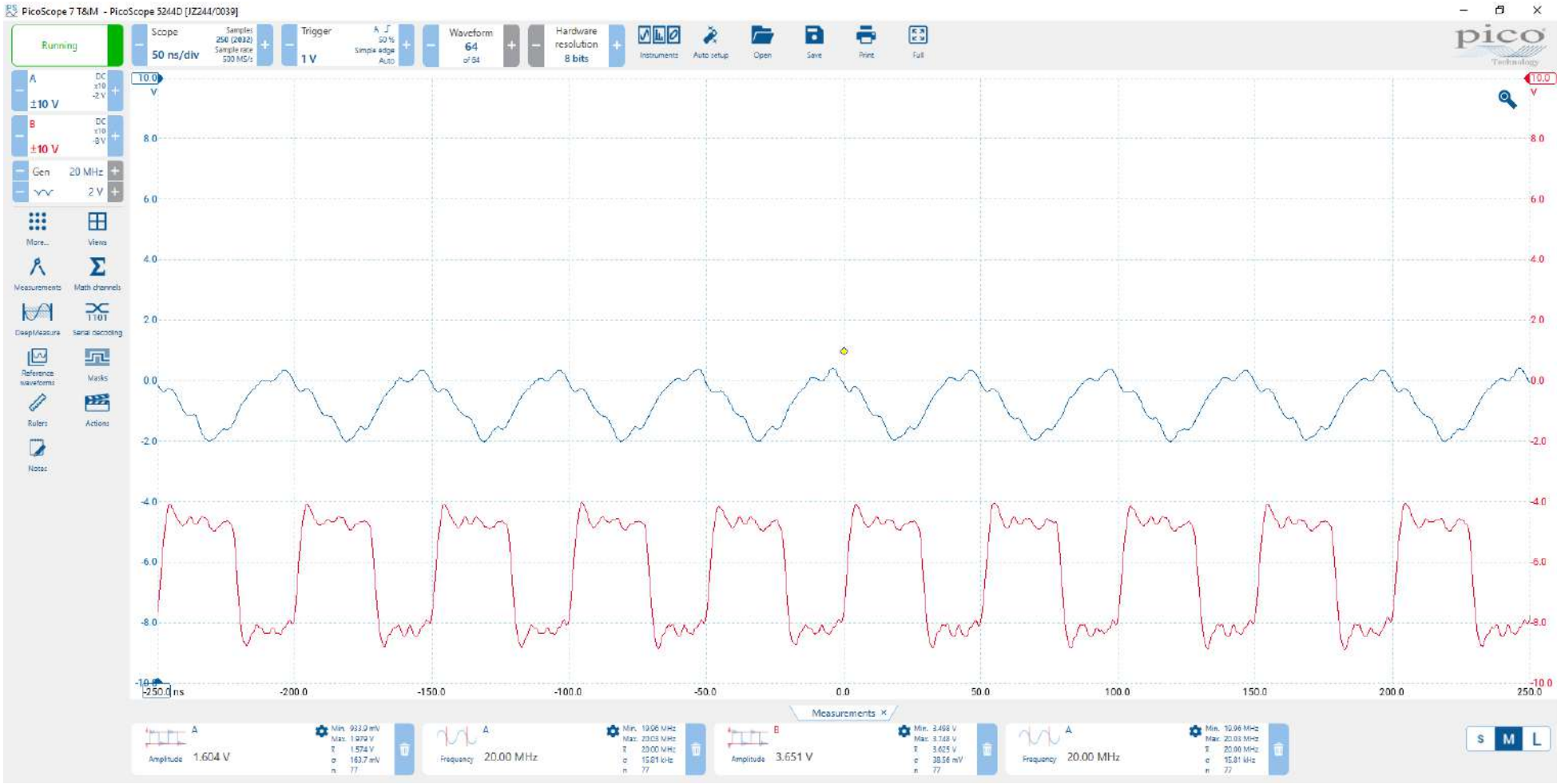
With ramp down input



MEASUREMENTS

Input Output

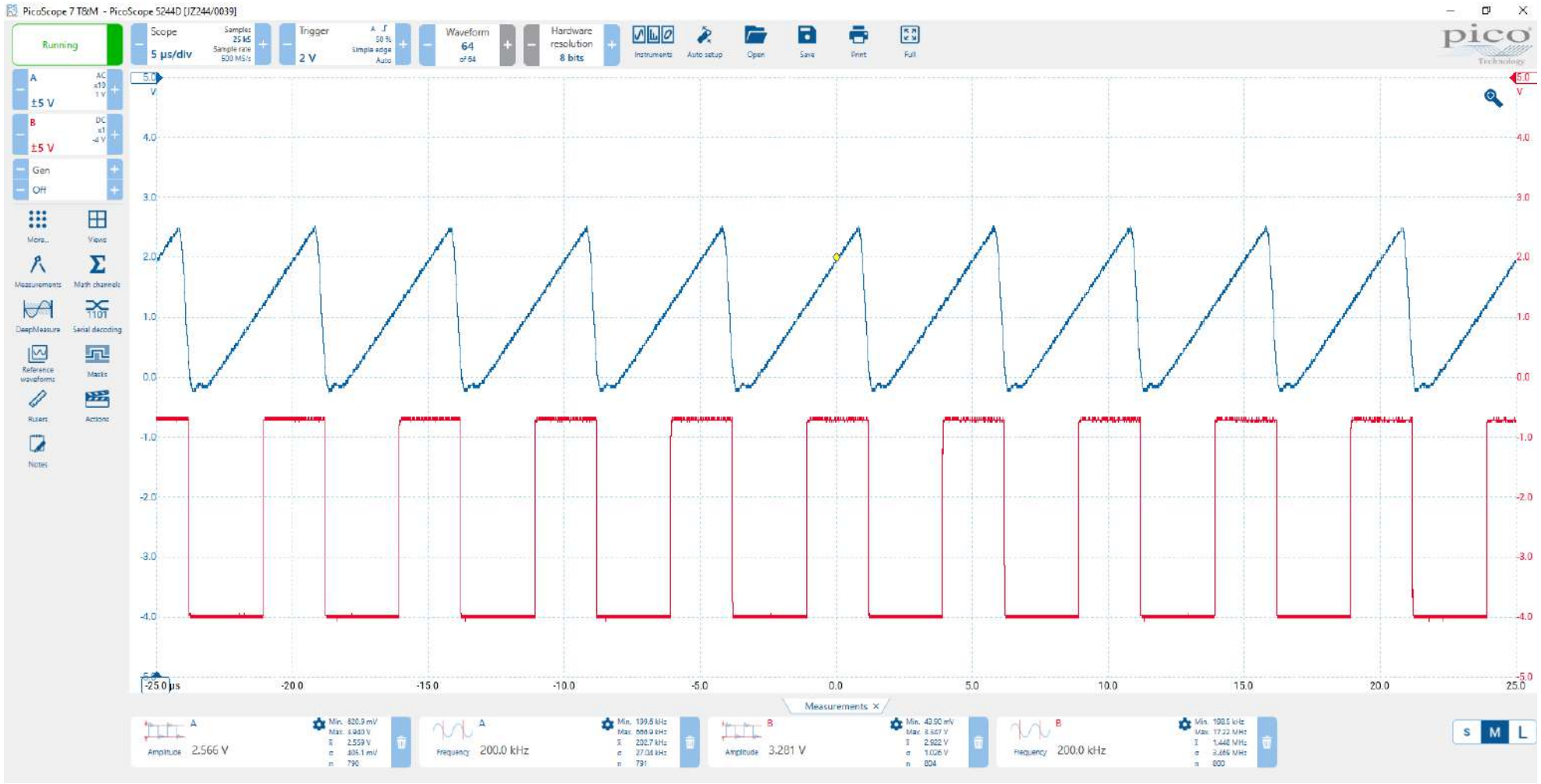
With half sine input



MEASUREMENTS

Input Output

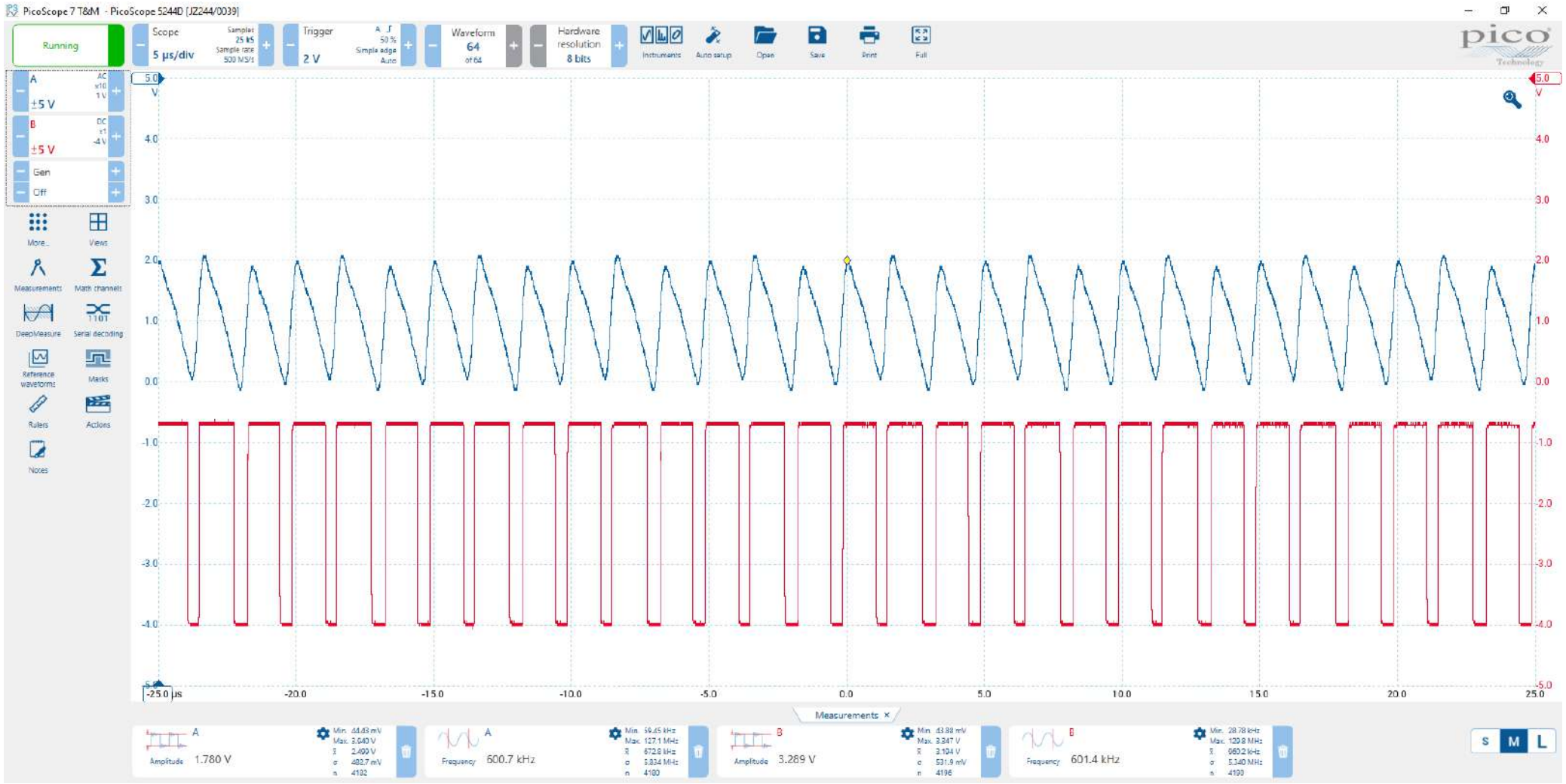
With sawtooth input



MEASUREMENTS

Input Output

With reverse sawtooth input



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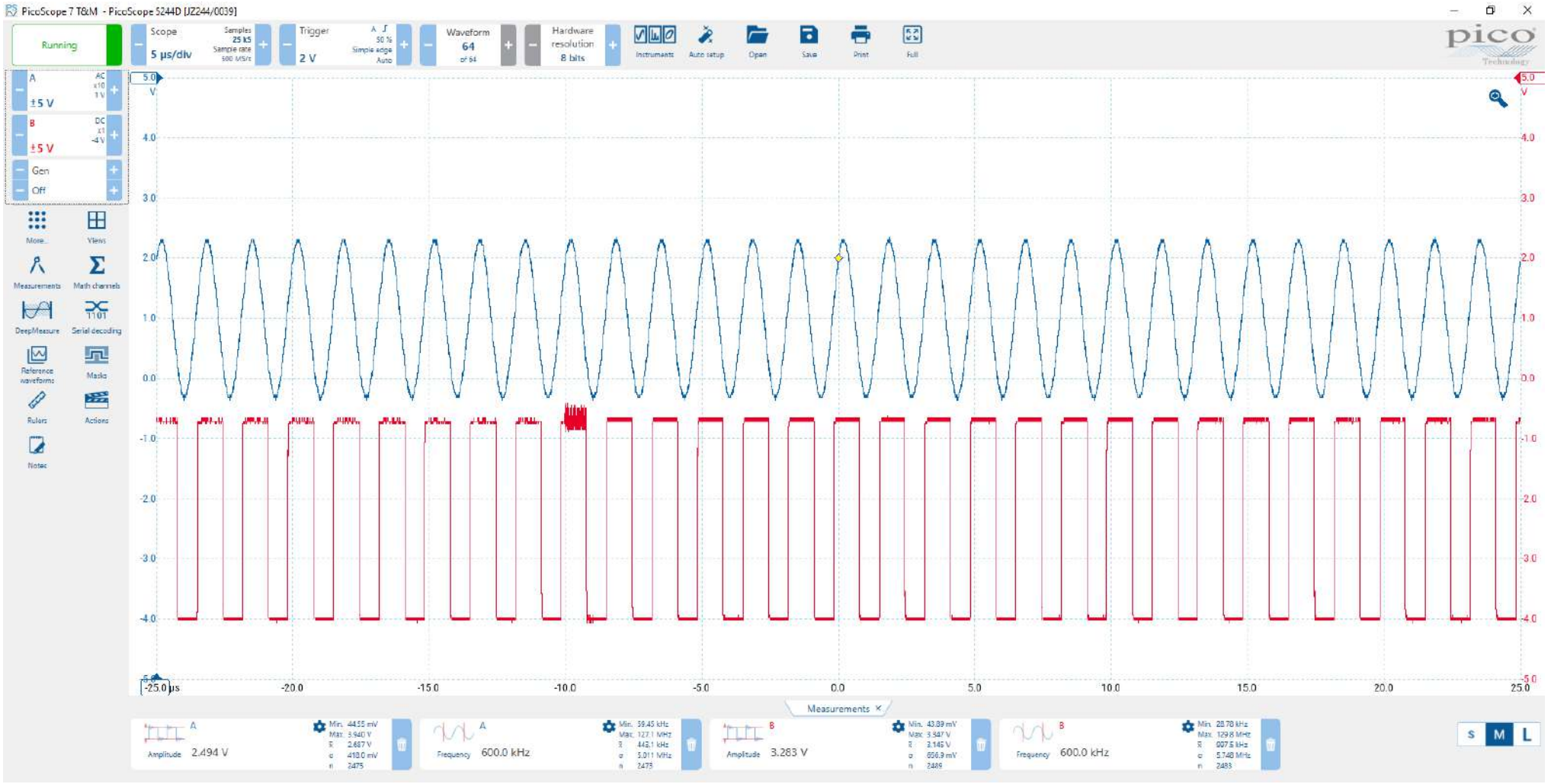
MEASUREMENTS

Input Output

With sine wave input



THANK YOU

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