



# Differential probes

## User's Guide

<b>TA041</b>	25 MHz $\pm 700$ V x10/x100
<b>TA042</b>	100 MHz $\pm 1400$ V x100/x1000
<b>TA043</b>	100 MHz $\pm 700$ V x10/x100
<b>TA044</b>	70 MHz $\pm 7000$ V x100/x1000
<b>TA057</b>	25 MHz $\pm 1400$ V x20/x200



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## 1. Description

TA041, TA042, TA043, and TA057 CAT III probes

These CAT III differential probes enable conventional oscilloscopes to display and measure in-circuit waveforms that are high-voltage or are referenced to high common-mode voltage. This extends the measurement capability of oscilloscopes to include electrical power conversion, inversion, motor speed control, switch-mode power supply and many other applications.

TA044 probe

The TA044 is an active differential probe suitable for high common-mode voltage measurement applications up to  $\pm 7000$  V (DC + peak AC). This differential probe extends the functionality of standard single-ended input oscilloscopes to allow a safe and accurate method of making high-voltage differential measurements. Applications include making safe measurements in power circuit applications and acquisition of low-speed balanced differential signals found in serial communications buses.

## 2. Safety

To prevent possible electrical shock, fire, personal injury, or damage to the product, carefully read this safety information before attempting to install or use the product. In addition, follow all generally accepted safety practices and procedures for working with and near electricity.

These probes have been designed and tested in accordance with the Harmonized Standard EN 61010-031:2015, and left the factory in a safe condition.






The following safety descriptions are found throughout this guide:

A **WARNING** identifies conditions or practices that could result in injury or death.

A **CAUTION** identifies conditions or practices that could result in damage to the product or equipment to which it is connected.

### Symbols

These safety and electrical symbols may appear on the product or in this guide.

Symbol	Description
	Earth (ground) terminal
	Equipment protected through double or reinforced insulation
	Possibility of electric shock
	Caution. Appearance on the product indicates a need to read these safety and operation instructions.
<b>CAT</b>	IEC 61010 overvoltage category
	Do not dispose of this product as unsorted municipal waste



## WARNING

To prevent injury or death use the product only as instructed. Protection provided by the product may be impaired if used in a manner not specified by the manufacturer.

## Maximum input ranges

Observe all terminal ratings and warnings marked on the product.



## WARNING

To prevent electric shock, do not use the probe with voltages above the absolute maximum values specified in the following table.

Model	Probe bandwidth	Differential range(s)	Absolute max. voltage	Safety CAT rating
TA041	25 MHz	±70/700 V	±1000 V pk max	1000 V CAT III
TA042	100 MHz	±140/1400 V	±1400 V pk max	1000 V CAT III
TA043	100 MHz	±70/700 V	±1000 V pk max	1000 V CAT III
TA057	25 MHz	±140/1400 V	±1400 V pk max	1000 V CAT III
TA044	70 MHz	±700/7000 V	5000 Vrms or ±7000 V (DC+Peak AC) in differential mode	non CAT rated

## WARNING

Signals exceeding the voltage limits in the table below are defined as “hazardous live” by EN 61010. To prevent electric shock, take all necessary precautions when working on equipment where hazardous live voltages may be present.

### Signal voltage limits of the Low Voltage Directive (LVD)

±60 V DC	30 V AC RMS	±42.4 V pk max.
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## WARNING

To prevent injury or death, the TA044 differential probe must not be directly connected to the mains (line power). To measure mains voltages, use a CAT III differential isolating probe specifically rated for mains use, such as the TA041.



## CAUTION

Operation outside of the safe voltage range is likely to cause permanent damage to the product and other connected equipment.

## Grounding



### WARNING

The probe's ground connection through the BNC cable is for measurement purposes only. The probe does not have a protective safety ground.

The probe can be grounded by connecting the BNC shell to a grounded measurement instrument, or by connecting the auxiliary grounding terminal to a reliable ground point. Some measurement setups, such as a USB oscilloscope connected to a laptop, are unlikely to be grounded even when the laptop is mains powered.

## External connections



### WARNING

To prevent electric shock, do not touch exposed connections and components when power is present.



### CAUTION

Take care to avoid mechanical stress or tight bend radii for all connected leads. Mishandling will cause deformation of sidewalls, and will degrade performance and measurement accuracy.

## Environment



### WARNING

To prevent injury or death, do not use in wet or damp conditions, or near explosive gas or vapor.

### WARNING

To avoid injury or death, always remove jewellery such as rings, watches and other metallic objects.



### CAUTION

To prevent damage, always use and store your probe in appropriate environments as shown below:

Temperature	-10 to 40 °C (operating) -30 to 70 °C (storage)
Humidity	25 to 85 %RH (operating and storage)
Altitude	2000 m
Pollution	Degree 2

### Care of the product

The product contains no user-serviceable parts. Repair, servicing and calibration require specialized test equipment and must only be performed by Pico Technology or an approved service provider. There may be a charge for these services unless covered by the Pico two year warranty.



**WARNING**

To prevent injury or death, do not use the product if it appears to be damaged in any way, and stop use immediately if you are concerned by any abnormal operations.

**WARNING**

To prevent injury or death, do not operate this probe with the covers removed.

**WARNING**

To prevent injury or death, do not tamper with or disassemble the probe or its accessories. Internal damage will affect performance.

**WARNING**

To prevent injury or death when cleaning the product, use a soft cloth and a solution of mild soap or detergent in water. To prevent electric shock, do not allow liquids to enter the casing, as this will compromise the electronics or insulation inside. Always ensure that the probe is dry before connecting it to the oscilloscope, power supply, or device under test.



## 3. Installation

Follow these instructions to install and start using your differential probe.

1. Simply plug in the BNC output connector to the vertical input of a general-purpose oscilloscope or other measurement instrument.
2. Connect to probe to an appropriate power source; internal batteries or TA531 USB to DC power lead.
3. Turn the probe on.
4. Set the attenuation ratio according to the table below.
5. Using the appropriate probe accessories, connect the input to the circuit under test.

Probe	Signal voltage	Attenuation ratio
TA041	< 70 V	1:10
	≥ 70 V	1:100
TA042	< 140 V	1:100
	≥ 140 V	1:1000
TA043	< 70 V	1:10
	≥ 70 V	1:100
TA044	< 700 V	1:100
	≥ 700 V	1:1000
TA057	< 140 V	1:20
	≥ 140 V	1:200



### WARNING

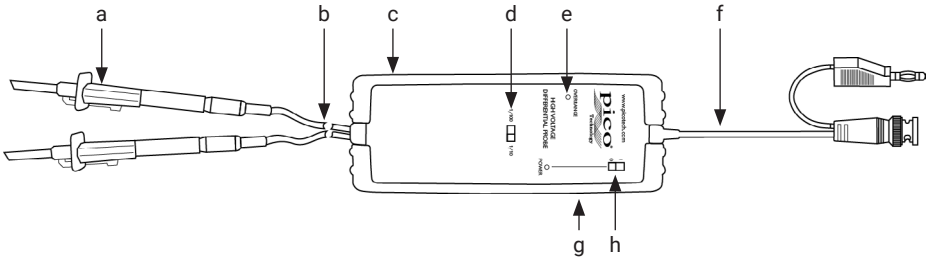
To protect against electric shock, use only the accessories designed for use with this differential probe.

### WARNING

To avoid injury or death, you must observe all safety precautions appropriate to the circuit under test.

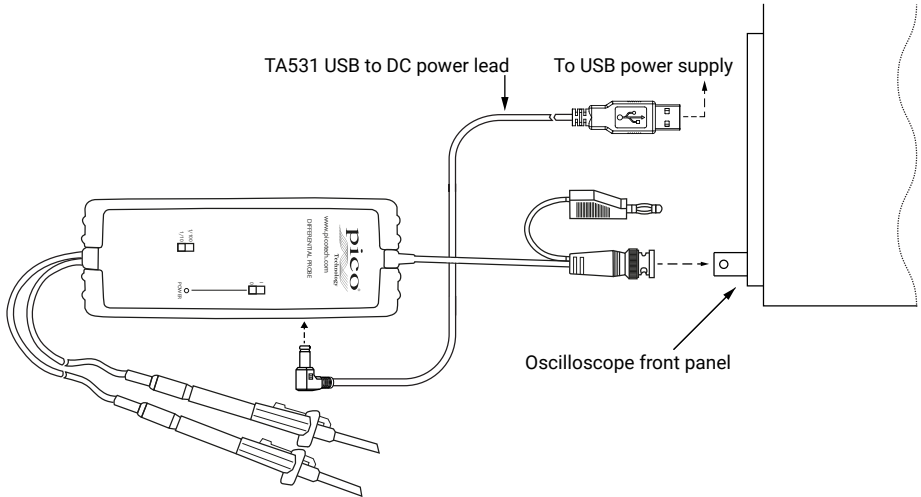
## 4. Appearance

TA041, TA042, TA043, TA044, and TA057 probes



- a. Sprung hooks  
The sprung hooks allow a safe connection to test points in the circuits under test.
- b. Input leads  
The input leads of the differential probe connect to the sprung hooks that are supplied with the probe.
- c. Probe body
- d. Attenuation ratio switch (some probes may have controls in a different configuration)
- e. Overage indicator
- f. Output lead  
The BNC output connector and an auxiliary grounding terminal are connected to the oscilloscope.
- g. DC power socket, for use with TA531 USB to DC power lead.  
See Section 5 for more information on connecting power leads.
- h. Power switch

## 5. TA531 USB to DC power lead



## 6. Overrange indicator

The overrange indicator lights up red if the voltage of the input signal exceeds the linear operating range of the probe. When this happens, the signal on the probe output may not accurately represent the signal on the probe input.

The overvoltage indicator is found on the front panel of the probe.

7. Specifications

	TA041	TA042	TA043	TA044	TA057
Bandwidth	DC to 25 MHz (-3 dB) 1:10 or 1:200 switchable	DC to 100 MHz (-3 dB) 1:100 or 1:1000 switchable	DC to 100 MHz (-3 dB) 1:10 or 1:100 switchable	DC to 70 MHz (-3 dB) 1:100 or 1:1000 switchable	DC to 25 MHz (-3 dB) 1:20 or 1:200 switchable
Attenuation ratio					
DC accuracy	±2%	±2%	±2%	±2%	±2%
Rise time	14 ns	3.5 ns	3.5 ns	5 ns	14 ns
Input impedance	4 MΩ    5.5 pF each side to ground	4 MΩ    7 pF each side to ground	4 MΩ    7 pF each side to ground	10 MΩ    10 pF each side to ground	4 MΩ    5.5 pF each side to ground
<b>Input voltages</b>					
Differential range *	±70 V (DC + peak AC) or 70 V RMS (1:10) ±1400 V (DC + peak AC) or 1000 V RMS (1:100) ±700 V (DC + peak AC) or 700 V RMS (1:10 and 1:100)	±140 V (DC + peak AC) or 140 V RMS (1:100) ±1400 V (DC + peak AC) or 1000 V RMS (1:1000) ±700 V (DC + peak AC) or 1000 V RMS (1:10 and 1:1000) or 700 V RMS (1:10 and 1:1000)	±70 V (DC + peak AC) or 70 V RMS (1:10) ±700 V (DC + peak AC) or 500 V RMS (1:100) ±700 V (DC + peak AC) or 700 V RMS (1:10 and 1:100)	±700 V (DC + peak AC) or 700 V RMS (1:100) ±7000 V (DC + peak AC) or 2500 V RMS (1:100 and 1:1000) or 7000 V (DC + AC peak) or 2500 V RMS (1:100 and 1:1000)	±140 V (DC + peak AC) or 140 V RMS (1:20) ±1400 V (DC + peak AC) or 1000 V RMS (1:200) ±1400 V (DC + peak AC) or 1000 V RMS (1:20 and 1:200)
Common mode range *					
Absolute max. voltage * (Common mode)	±1400 V (DC + AC peak) or 1000 V RMS CAT III (1:10 and 1:100)	±1400 V (DC + AC peak) or 1000 V RMS CAT III (1:100 and 1:1000)	±1000V (DC + AC peak) or 1000V RMS CAT III (1:10 and 1:100)		±1400V (DC + AC peak) or 1000 V RMS CAT III
<b>Output</b>					
Swing	±7 V into 1 MΩ load	±1.4 V into 1 MΩ load	±7 V into 1 MΩ load	±7 V into 1 MΩ load	±7 V into 1 MΩ load
Offset (typical)	< ±5 mV	< ±5 mV	< ±5 mV	< ±5 mV	< ±5 mV
Noise (typical)	0.7 mV RMS	0.9 mV RMS	0.9 mV RMS	0.9 mV RMS	0.7 mV RMS
Source impedance (typical)	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω
CMRR (typical)	86 dB at 50 Hz, 66 dB at 20 Hz.	80 dB at 60 Hz, 50 dB at 1 MHz.	85 dB at 50 Hz, 55 dB at 1 MHz.	80dB at 50Hz, 60dB at 20kHz	86 dB at 50 Hz, 60 dB at 20 kHz.
Temperature			-10 to 40 °C (operating) -30 to 70 °C (storage)		
Humidity			25 to 85 %RH (operating and storage)		
<b>Power requirements</b>					
Battery **			4 x AA cells		
Mains adaptor(s) **	6 V DC 60 mA or regulated 9 V DC 40 mA	6 V DC 200 mA or regulated 9 V DC 120 mA	6 V DC 200 mA or regulated 9 V DC 120 mA	6 V DC 200 mA or regulated 9 V DC 120 mA	6 V DC 60 mA or regulated 9 V DC 40 mA
Optional			TA531 Power lead		
Input cable	45 cm	30 cm	30 cm	60 cm	45 cm
BNC cable	95 cm	90 cm	90 cm	90 cm	95 cm
Weight	400 g (inc. probes and PVC jacket)	500 g	500 g	500 g	400 g (inc. probe and PVC jacket)
Dimensions (L x W x H)	170 mm x 63 mm x 21 mm	202 mm x 83 mm x 38 mm	202 mm x 83 mm x 38 mm	202 mm x 83 mm x 38 mm	170 mm x 63 mm x 21 mm

Specification table notes:

\* Voltage limit is the lesser of the DC + AC peak and RMS values.

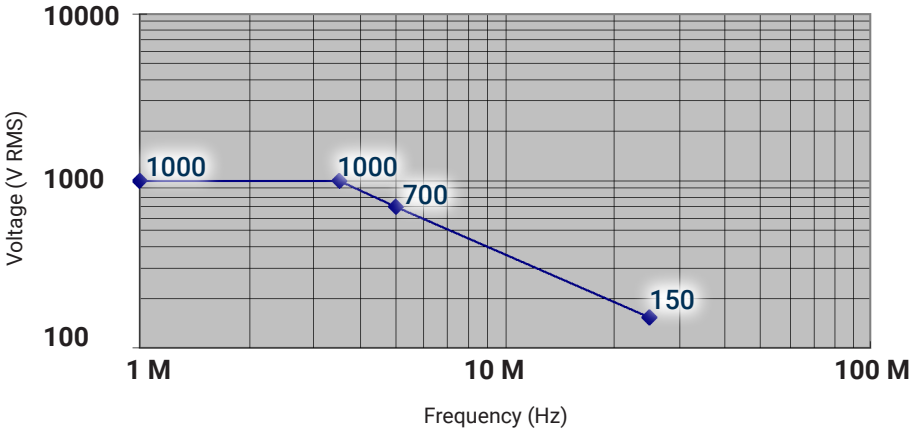
\*\* a. The supplied voltage must be between 3.3 V and 16 V (TA057), or 4.4 V and 12 V (all other models). Voltages outside of this range may damage the probe or affect performance.

b. Polarity is "+" inside and "-" outside. If the polarity is wrong, a built-in circuit protects the probe so that no danger or damage will occur.

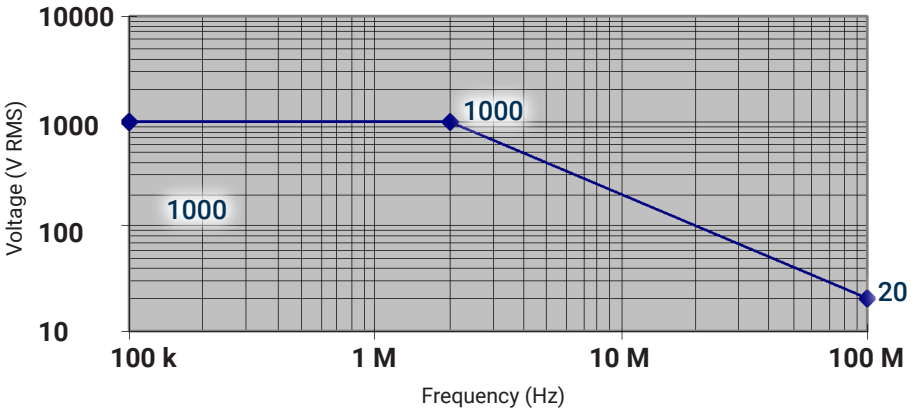
c. When the voltage of the cells becomes too low, the power indicator on the panel will flash red and green, then switch off (TA057 and TA041) or flash red and switch off (all other models).

8. Derating curves

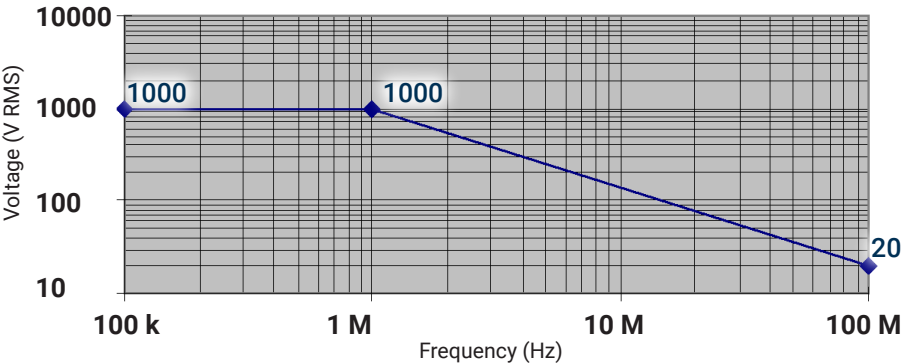
The derating curves for absolute maximum input voltage of each probe model are shown below:  
TA041 and TA057



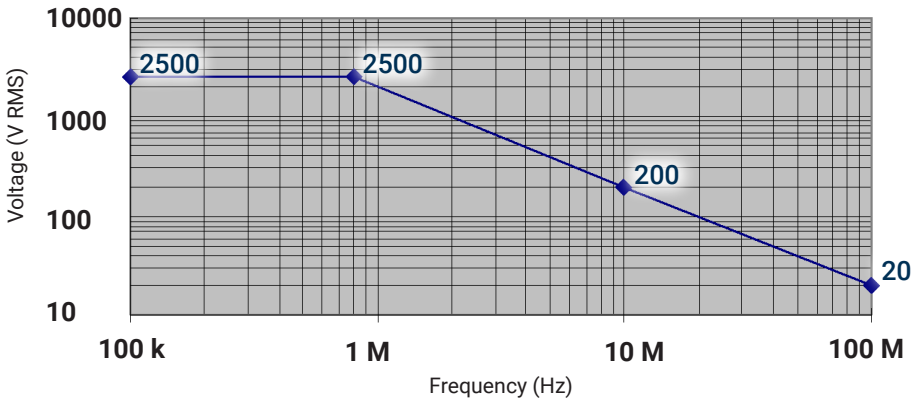
TA042



TA043



TA044



## 9. Test procedure

1. Connect the BNC output connector to the vertical input of a general-purpose oscilloscope.
2. Connect the probe to an appropriate power source, such as the mains adaptor or four AA cells.
3. Turn on the probe using the power switch.
4. Set the oscilloscope input to DC coupling and 1 V/div. Center the trace on the display.
5. Connect the sprung hooks of the probe to the circuit under test.
6. A 50 Hz or 60 Hz sine wave of proper amplitude will be displayed on the screen of the oscilloscope. This demonstrates that the probe is working properly.

## 10. Calibration

There are three main sources of uncertainty when calibrating a Pico differential probe in addition to any uncertainty in the test setup. These are:

1. The stated DC accuracy of the probe under test (see specifications table).
2. Any DC offset or noise in the probe output. The values in this manual are typical, so to find the DC offset for a given unit a reading must be taken with the inputs to the probe shorted together.
3. The AC performance of the probe. This is specified as being within 3 dB over the entire frequency range of the probe. Any absolute voltage accuracy testing must be done under DC conditions.

One other possible cause of noise is the probe's power source. It is recommended that, where possible, probes are calibrated using a battery supply rather than a mains supply unit.

The adjustment procedure is available from Pico Technology on request.

## 11. Zero probe offset

The probes can be adjusted for zeroing out the probe's offset voltage using a trimmer tool supplied with the probe. Follow this procedure to perform the offset-zero calibration:

1. After turning on the power to the oscilloscope and probe, leave them on for >30 minutes to stabilize. You may use the USB power cord or batteries to power the probe.
2. Connect the probe to channel A of your oscilloscope.
3. Short the + and – probe inputs together with the hook tips.
4. Select Auto range in the oscilloscope software.
5. Then set units to Volt and select the lowest attenuation.
6. Set the ocsilloscope to DC coupled mode.
7. Position the ground of the waveform to the centre of the screen and set the vertical scale to 10 mV/div or 20 mV/div.
8. Set the oscilloscope to Averaging mode (x8 or higher) or High resolution mode to reduce scope noise.
9. Using the trimmer tool supplied with the probe, adjust the probe offset voltage to 0 V.

## 12. Cleaning

Only use a soft, damp cloth to clean the probe.



### WARNING

To prevent injury or death, always ensure the probe is thoroughly dry after cleaning.



### CAUTION

To prevent damage to the probe and other connected equipment, do not immerse the probe in any liquids.

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