A3000 Series active probes

for PicoScope 6000E Series oscilloscopes

User's Guide

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Contents

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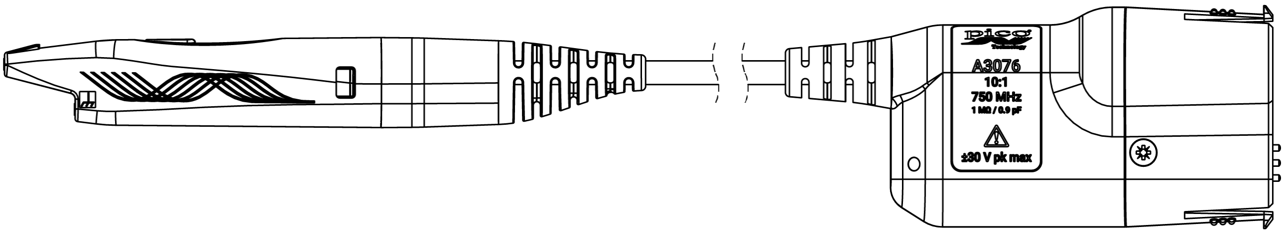
1 Introduction

1.1 Overview

The Pico A3000 Series Active Probes are high-impedance, high-bandwidth oscilloscope probes with an Intelligent Probe Interface for use with PicoScope 6000E Series oscilloscopes.



The following models are available:

- Pico A3076 750 MHz 10:1 active probe - recommended for 750 MHz oscilloscopes
- Pico A3136 1.3 GHz 10:1 active probe - recommended for 1 GHz oscilloscopes

1.2 Safety information

To prevent possible electrical shock, fire, personal injury, or damage to the product, carefully read the safety information in the *Quick Start Guide* supplied with the probe before attempting to install or use the product. In addition, follow all generally accepted safety practices and procedures for working with electrical equipment.

1.3 Trademarks

Pico Technology and *PicoScope* are trademarks of Pico Technology Limited, registered in the United Kingdom and other countries.

PicoScope and *Pico Technology* are registered as trademarks in the U.S. Patent and Trademark Office.

1.4 Warranty

Pico Technology **warrants** upon delivery, and for a period of 2 years unless otherwise stated from the date of delivery, that the Goods will be free from defects in material and workmanship.

Pico Technology shall not be liable for a breach of the warranty if the defect has been caused by fair wear and tear, willful damage, negligence, abnormal working conditions or failure to follow Pico Technology's spoken or written advice on the storage, installation, commissioning, use or maintenance of the Goods or (if no advice has been given) good trade practice; or if the Customer alters or repairs such Goods without the written consent of Pico Technology.

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2 Product information

2.1 What do I get?

Each Pico A3000 Series probe is supplied with the following items:

Part number	Quantity	Description
TA469	1	Fixed probe tip x 10
TA501	1	Sprung probe tip x 10
TA470	1	Ground blade (2 sizes x 2 of each)
MI490	2	Ground lead
TA494	1	Channel markers (channels A to D)
TA495	1	Channel markers (channels E to H)
TA502	1	Solder-in cable pin x 10
WI027	1	Gold-plated copper wire 0.3 mm
TA504	1	SMD pincer, black
TA505	1	SMD pincer, red
TA471	2	Joggle adaptor
PA184	1	Carry case
DO350	1	Quick Start Guide

The following accessory kit is also available for purchase:

Order code	Description
PQ275	A3000 probe accessory kit with: • Ground leads x 2 • Solder-in cable pins x 10 • Gold-plated copper wire 0.3 mm • Joggle adaptor

Other replacement accessories are available for purchase individually on www.picotech.com.

2.2 Measurement principles

Pico A3000 Series probes are very compact to minimize their parasitic capacitance and inductance, and to ease probing and connection to today's fine-geometry systems.

There are two basic probe requirements:

- High signal integrity:

Ideally, the probed signal that is transmitted to the oscilloscope should be identical to that seen between the probe tips. Perfect signal transfer is impossible but a high-bandwidth probe gives a good approximation.

- Low signal loading:

When a probe is connected to the device under test (DUT), the signal to be measured will change. The A3000 probe's high input impedance and low input capacitance minimize the effect on the DUT.

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2.3 Probe input equivalent circuit

Probe parameters are determined using the connection between the probe and DUT. The probe is fed by a source with a 50 ohm internal impedance and is terminated into 50 ohms.

Figure 1 shows the equivalent circuit model of a probe connected to a DUT.

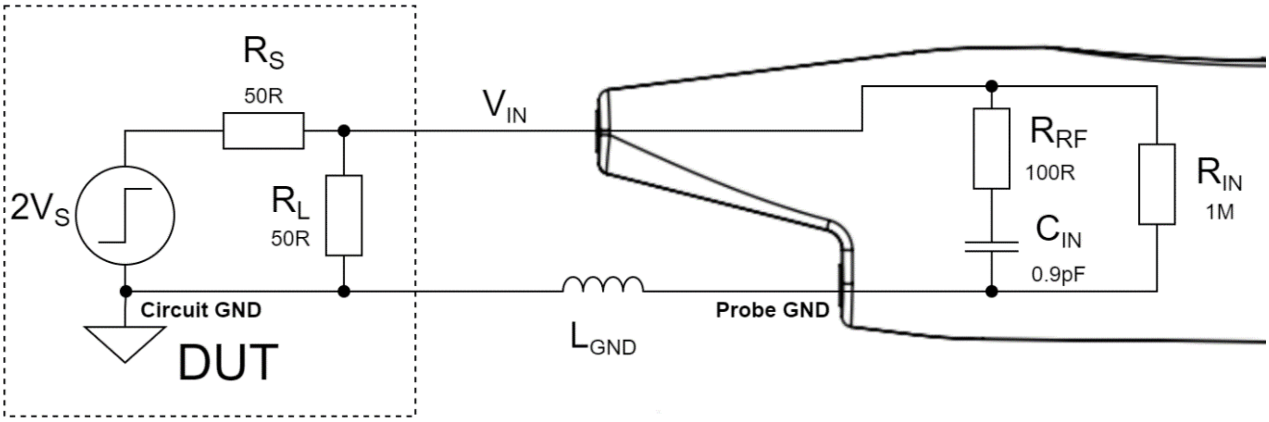

Figure 1: A3000 Series equivalent circuit

Symbol	Meaning
V_S	Voltage at the test point without probe connected
V_{IN}	Voltage at the test point with probe connected, corresponds to the input voltage of the probe
R_S	Source resistance of the DUT
R_L	Load resistance of the DUT
R_{IN}	DC input resistance
C_{IN}	Input capacitance of the probe
R_{RF}	RF input resistance of the probe
L_{GND}	Parasitic inductance of the ground connection

2.4 Integrity of the transferred signal

Bandwidth
One important parameter of a probe is its bandwidth. This bandwidth and that of the oscilloscope form the system bandwidth. For a sinusoidal signal, bandwidth is the maximum frequency at which the transferred signal stays above 70% (–3 dB) of its true amplitude. To maintain reasonable signal integrity for square wave signals, the bandwidth of the probe should exceed at least the fifth harmonic of the signal being measured. Figure 2 indicates the bandwidth of a typical A3136 probe.

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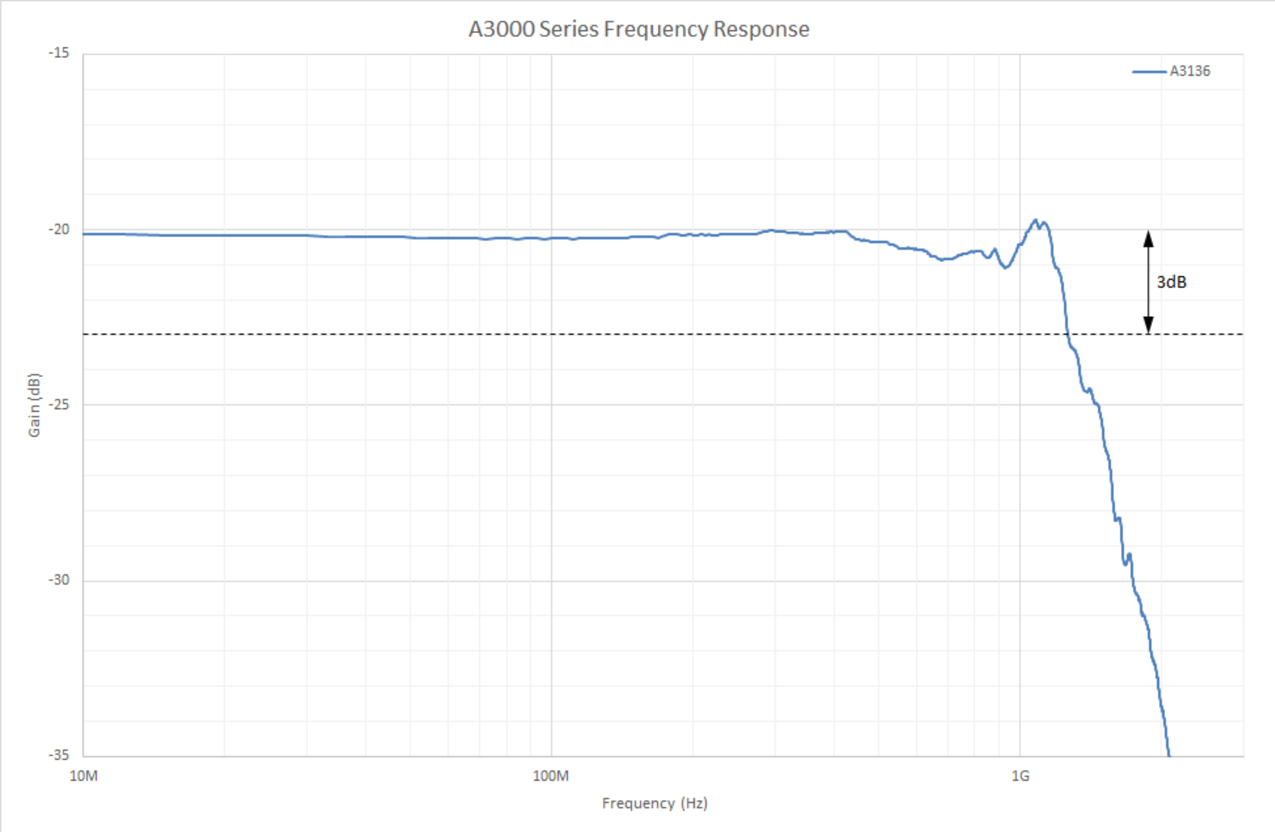

Figure 2: A3000 Series probe bandwidth

As well as sufficient bandwidth, a high-quality probe should also have a flat frequency response. The typical response of an A3000 probe is shown above. The gain is roughly constant at all frequencies, reducing distortion.

Rise time

Rise time (t_{rise}) is the time taken for the probe output to change from 10 % to 90 % in response to a step change in the input voltage. It is related to the bandwidth by the approximation:

$t_{rise} \approx 0.35/BW$

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Figure 3 below shows a typical step response of an A3000 Series probe:

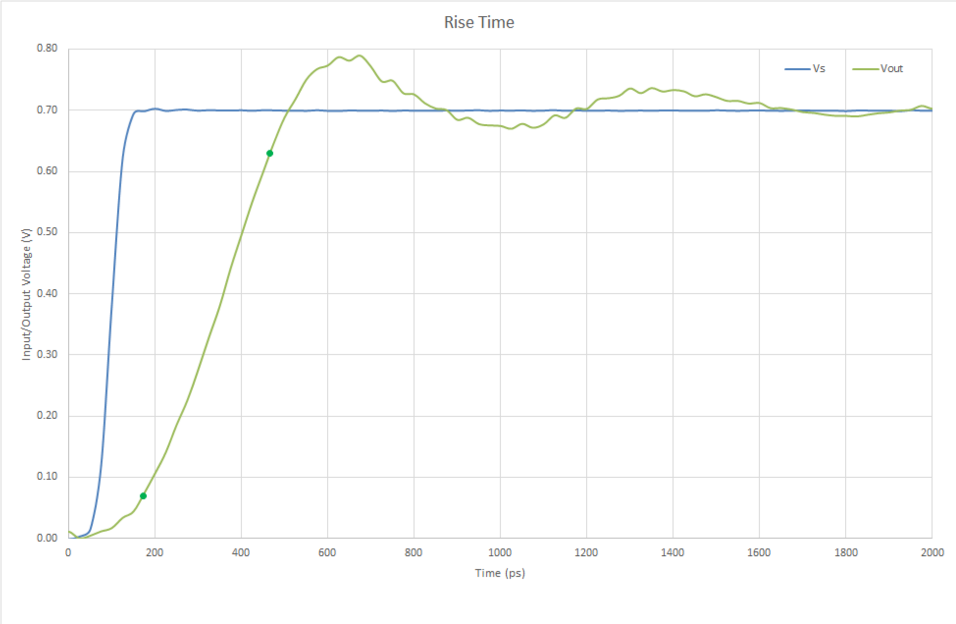

Figure 3: A3000 Series step response

2.5 Loading of the input signal

Input impedance
The input signal loading caused by the probe depends on its input impedance Z_{IN}. Figure 1 presents an equivalent circuit model.

Z_{IN} consists of the following parameters.

- Input resistance R_{IN}
- Input capacitance C_{IN}
- RF resistance R_{RF}

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The resulting input impedance versus frequency is indicated in Figure 4.

At very high frequencies, probe tip capacitance causes the impedance to drop below the probe's DC resistance.

The A3000 probe's low tip capacitance of 0.9 pF minimizes its effect on the DUT, as shown in the following graph:

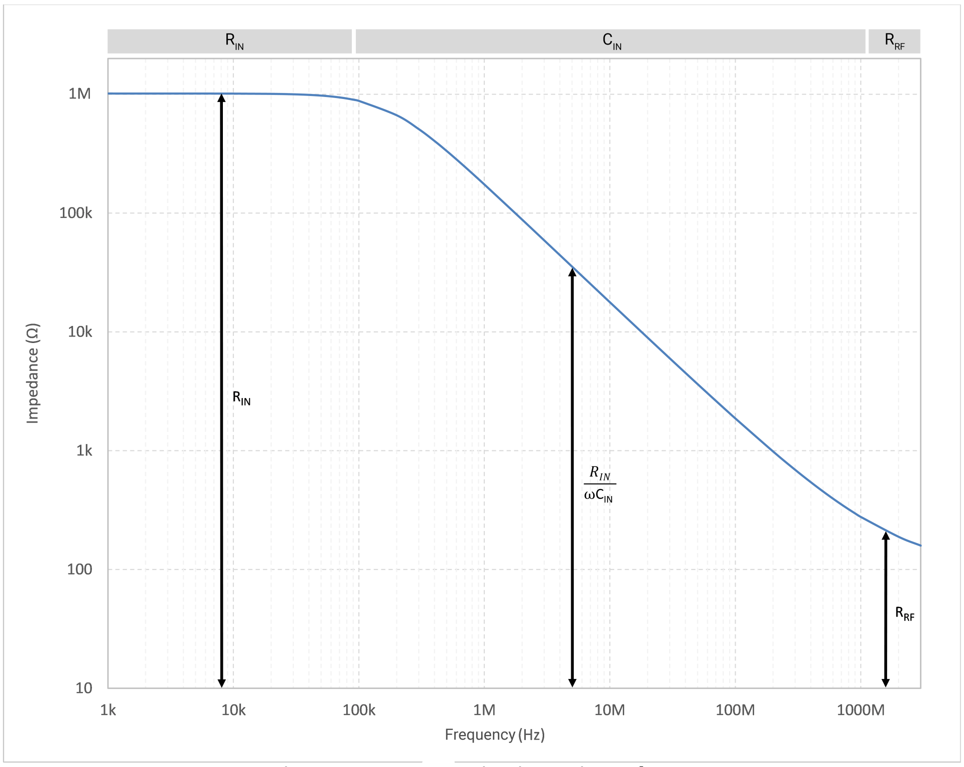

Figure 4: A3000 Series input impedance

The trace shows three characteristic areas dominated by R_{IN}, C_{IN} and R_{RF}. The resulting effect on a step signal at the input of the probe is shown in Figure 5:

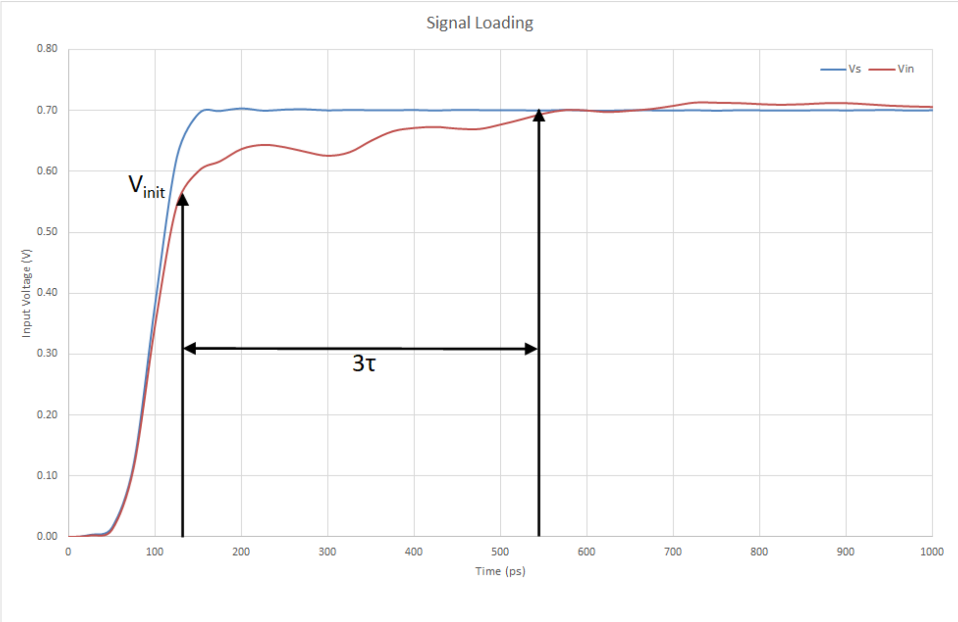

Figure 5: Signal loading

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where

$$\tau \approx C_{IN}(R_{RF} + R'_S)$$

$$V_{init} \approx V_S \frac{R_{RF}}{R'_S + R_{RF}}$$

Where: R'_s is the effective source impedance formed by the parallel combination of: $R'_S = R_S \,||\, R_L$

The connection inductance L_{GND} has only a minor effect on the signal loading and is therefore not taken into account in the figure.

Input resistance R_{IN}

The input resistance determines the loading of the DUT at DC and very low frequencies (< 100 kHz). A low input resistance can potentially disturb measurements of high-frequency signals as it influences the DC operating point of active components. This effect is negligible for the majority of applications involving the A3000 Series probe due to the very high input resistance of the probe (1 MΩ).

Input capacitance C_{IN}

The input capacitance causes the input impedance to decrease in the medium frequency range (100 kHz to 1.0 GHz). Thus, the measurement result depends on the source impedance of the DUT. The input capacitance affects the settling time 3τ of the input voltage in the case of fast transients. See signal loading graph in Figure 5 above.

RF resistance R_{RF}

The RF resistance determines the minimum input impedance and thus the maximum loading at very high frequencies above 1.0 GHz. Thus, the measurement result depends on the source impedance of the DUT. The RF resistance slows down fast transients. The initial voltage V_{init} depends on R_{RF} as shown in Figure 5.

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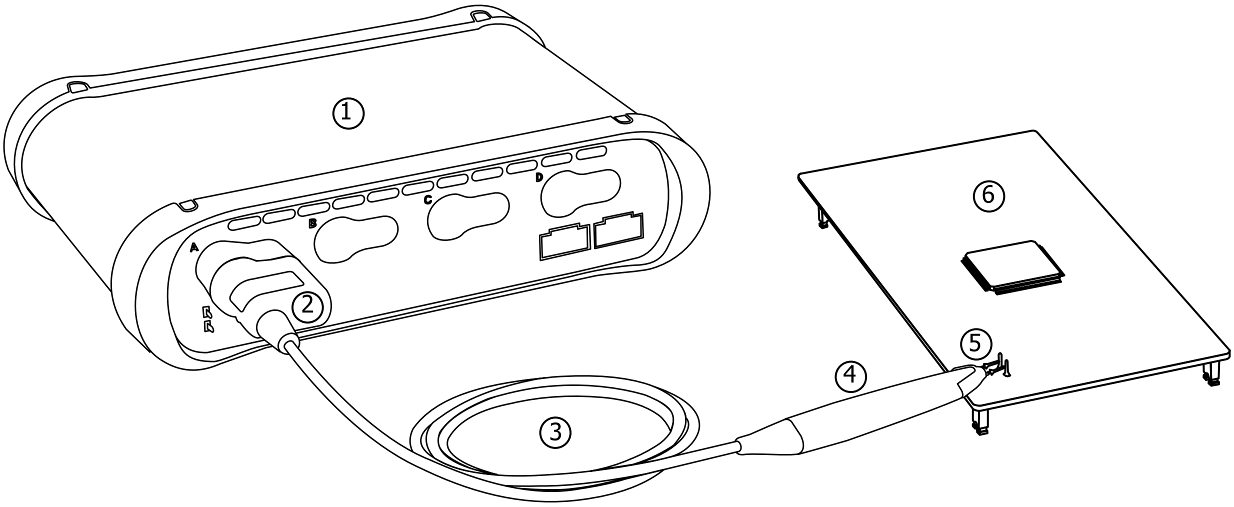
3 How to use your active probe

3.1 Connection diagrams



Connection of the probe to the Intelligent Probe Interface on the oscilloscope:

1. PicoScope 6000E Series oscilloscope
2. Scope-to-probe connection with integrated status LED
3. Probe cable
4. A3000 Series active probe
5. Joggle adaptor fitted with probe tips
6. Device under test.

Specific LED colors indicate the status of the probe:

Status	Color
Plugged in	Yellow
Busy/initializing	Cyan
Ready/idle	Green

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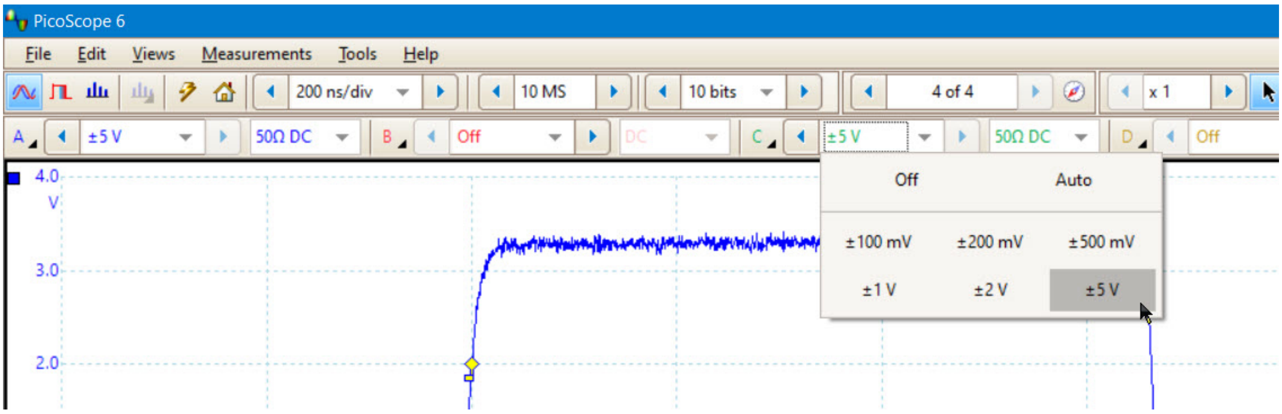
4 PicoScope 6 software

The PicoScope software recognizes A3000 Series probes using the Intelligent Probe Interface, so all you need to do is plug in the probe and select the desired measuring range.



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5 PicoSDK software

For information on controlling the A3000 Series probe from your own application, refer to the PicoScope 6000 Series (A API) Programmer's Guide

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6 Specifications and characteristics

6.1 General performance

Refer to the A3000 Series Active Oscilloscope Probes Data Sheet

6.2 Offset control and input dynamic range

The offset control can compensate for the DC component of the input signal. This control is useful when measuring AC signals with a large DC component.

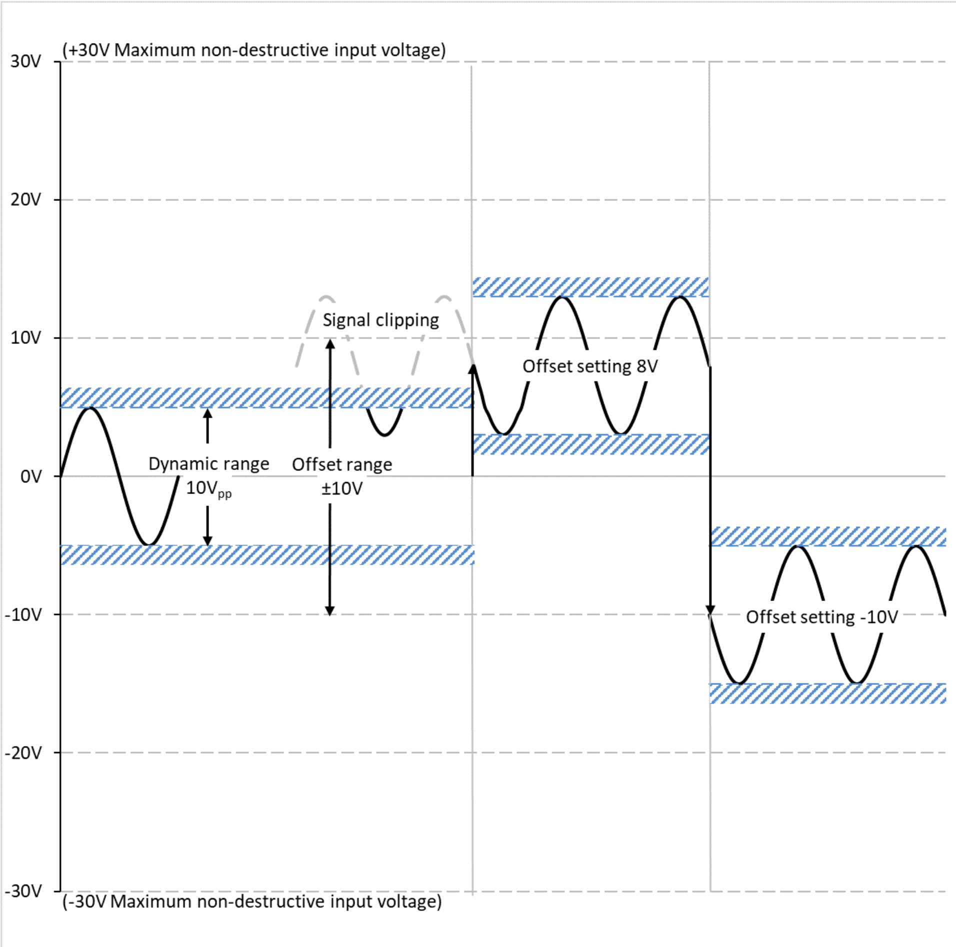

Figure 6: Dynamic range

⚠ The maximum non-destructive input voltage is ±30 V. An input voltage higher than this may destroy the probe.

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