

PicoConnect[®] 900 Series

Gigabit, RF, microwave and pulse passive test probes



Low cost

From only \$699

Gigabit probe heads

For Ethernet, USB 3, HDMI, SATA, PCI, LVDS
Up to 9 GHz bandwidth (18 Gb/s serial data rate)
Down to 40 ps transition time

RF, microwave and pulse probe heads

Up to 5 GHz bandwidth
Down to 70 ps transition time

Low input capacitance

0.3 pF typical, 0.4 pF maximum

Standard instrumentation interface

Fits all SMA, K and PC3.5 50 Ω input ports

Convenient

Available individually or as sets of six
Supplied with precision low-loss cable and solder-in kit
12 models for different applications

The shape of probes to come

The PicoConnect 900 Series low-invasive, high-frequency passive probes are designed for microwave and gigabit applications up to 9 GHz and 18 Gb/s. They deliver unprecedented performance and flexibility at a low price.

The probes employ a unique in-PCB construction to realize extremely low capacitance, coplanar microwave integrity, robust reliability and very low cost. The result is a family of miniature interchangeable passive probe heads that cover a range of division ratios, bandwidths and coupling types.

Gigabit digital probes

- High-speed logic voltage applications
- Up to 9 GHz
- Up to 18 Gb/s
- Less than 40 ps transition time
- Suited to Ethernet, USB3, HDMI, SATA, PCI, LVDS and other high-speed cabled, chip-to-chip and backplane interfaces

RF and microwave probes

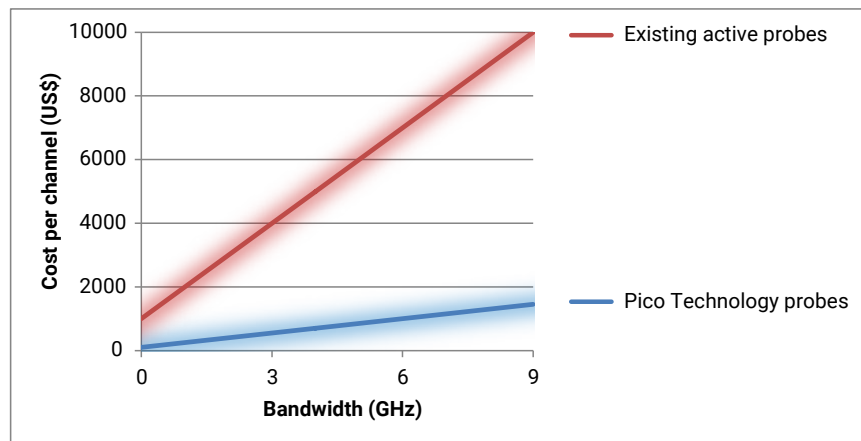
- High crest-factor pulse capability
- Up to 5 GHz
- Less than 70 ps transition time



Price breakthrough

At 1 GHz and above and supplied by just a few manufacturers, the majority of available test probes have been of familiar oscilloscope probe shape but with an active buffer amplifier within the probe body. They are mechanically complex, quite bulky, often heavy and always costly. In a survey of all available active probe models between 3 GHz and 30 GHz, we found that list prices lay on or above the \$1000 + \$1000/GHz line. Of course you need to multiply this by the number of signal channels to be probed.

The 900 Series passive probes all lie close to the \$100 + \$150/GHz line, less when purchased as a kit. Compared to the competition, that is less than one sixth of the cost per channel!



Features of the 900 Series probes

- Interchangeable probe heads at division ratios of 5:1, 10:1 and 20:1, AC or DC-coupled.
- Extremely low loading capacitance of < 0.3 pF typ., 0.4 pF upper test limit.
- Accurate probing of high speed transmission lines for $Z_0 = 0 \Omega$ to 100Ω
- Stated probe ratio compensated to correct for loading of low-impedance probe input.
- Class-leading uncorrected pulse/eye response and pulse/eye disturbance.
- Slim, fingertip design for accurate and steady probing or solder-in at fine scale.
- Passive design gives high dynamic range, low noise, linearity and long-term flatness
- Tolerant of very high input slew rate, and no saturation and recovery characteristic.
- Screened to minimize noise or response change from finger proximity and EMI.
- Supplied with robust, high-performance, highly flexible low-loss microwave coaxial cable.



The most flexible high-frequency probes

Interchangeable division ratio

Because of the ever-present limitations upon slew rate, high-speed digital signals have moved to lower and lower amplitudes, with some operating at only 100 mV swing. Inevitably, to raise probing impedance when using a low-cost probe, we have to divide this voltage to an even lower amplitude. The PicoConnect 900 Series interchangeable probe heads optimize this process by providing three division ratios to bring you the right probe ratio for each application. The 5:1 ratio is a particularly attractive and slightly faster option when probing low-swing logic.

AC or DC coupled probe head

Pico also brings the flexibility of AC or DC coupling, again through selection of interchangeable probe heads. Low-impedance probes load the probed signal, slightly reducing the amplitude, and if the signal has a DC bias they will source or sink current to or from the signal source, potentially changing the device operating bias. The AC-coupled probe avoids the DC bias problem. Low-frequency 3 dB cut-off is less than 160 kHz and droop of pulse top or base is < 0.1%/ns on all AC-coupled models. Applications for AC-coupled probing include DC-biased data streams such as HDMI, USB, SATA, ECL and PECL; and the probing of small signals on supply and control lines, as when looking for current noise or decoupling problems.

Load-compensated divide ratio for multiple typical line impedances

The PicoConnect 900 Series low-impedance probes are suited only to the probing of relatively low-impedance test nodes, typically in the range 0 Ω to 100 Ω . Many applications involve probing terminated transmission lines, generally 50 Ω , 45 Ω or 75 Ω single-ended. It is also common to use two probes on 100 Ω or 90 Ω differential lines (50 Ω or 45 Ω single-ended). On the assumption of a test node impedance in this range, the 900 Series probes are ratio-compensated and give a maximum ratio error as follows:

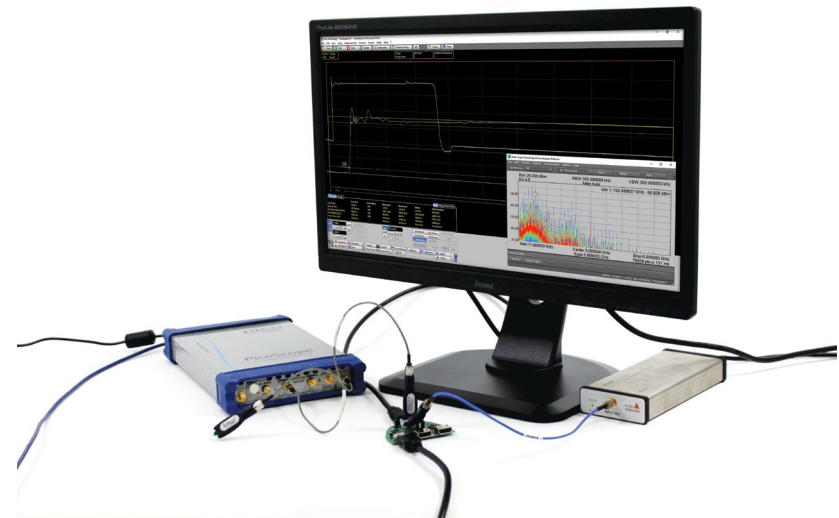
Transmission line impedance	Error with probes of $\leq 250 \Omega$	Error with probes of $> 250 \Omega$
0 Ω node	+11% (+0.9 dB)	+6% (+0.5 dB)
45 Ω -20% line, 90 Ω differential (22.5 Ω node)	+3.5% (+0.3 dB)	+2.4% (+0.2 dB)
50 Ω +20% line, 100 Ω differential (25 Ω node)	-3.5% (-0.3 dB)	-2.4% (-0.2 dB)
75 Ω line (37.5 Ω node)	-6% (-0.54 dB)	-3% (< -0.26 dB)
100 Ω line (50 Ω node)	-11% (-1.0 dB)	-6% (-0.5 dB)

Probes for use with a wide range of instrumentation

The PicoConnect 900 Series passive probes are suitable for use with any measurement instrument with 50 Ω input impedance, including:

- Oscilloscopes
- Sampling oscilloscopes
- Receivers
- Spectrum and modulation analyzers
- Power meters
- Millivoltmeters
- Network analyzers

Standard connectorized SMA, PC3.5 and K accessories such as attenuators, signal dividers, multiplexers, filters and cables of varying length and performance can also be placed in series with the probe output to further condition or route the signal.



Probing was a compromise ... until now

There is a rapidly proliferating need to probe, measure and view very high speed and broadband signals. Gigahertz signal frequencies were once the domain of radio and microwave engineering and were typically localized and narrowband within any given system. Today, a multiplicity of broadband signals are routinely found within digital and computing systems, personal communication, media and gaming devices, and position, sensing and control systems. Engineers now demand that these measurements, once the domain of relatively few highly skilled microwave engineers using high-cost instrumentation, be simpler and much cheaper to perform.

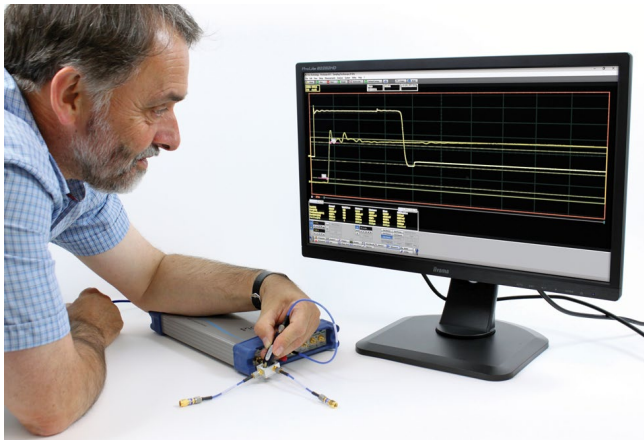
The problem with invasive measurements

High-frequency and broadband signals typically propagate in transmission lines, whose transmitted efficiency and signal integrity rely on consistent characteristic impedance along their length. In turn, characteristic impedance is determined by conductor and insulator materials and their geometries relative to each other and adjacent grounds. These too must remain consistent if signal losses and reflections are to be minimized.

The challenge is to make contact with and measure these high-frequency or broadband signals without significant disturbance of the signal or, by inference, the transmission lines that carry them. This would be a non-invasive or, more realistically, a low-invasive measurement.

Until now, microwave probing solutions have tended to be bulky, too invasive, too expensive, with poor measurement repeatability and in some cases mechanically or electrically fragile. As a result, transmission lines under test have often been physically interrupted and either rerouted to, or power-divided to, a terminating measurement instrument. While this method produces very accurate measurements, it can also be inconvenient or impractical in cases such as these:

- Signal interruption, delay or attenuation may disturb the system function while under test.



- The interruption and subsequent repair of fine pitch or buried PCB tracking.
- Multiple system signal paths may need to be interrupted and fitted with matching pick-off networks and propagation delays, even if only one needs to be measured.

The 900 Series passive probes are a cost-effective and long overdue solution in all of these cases.

The principle behind the PicoConnect 900 Series passive probes

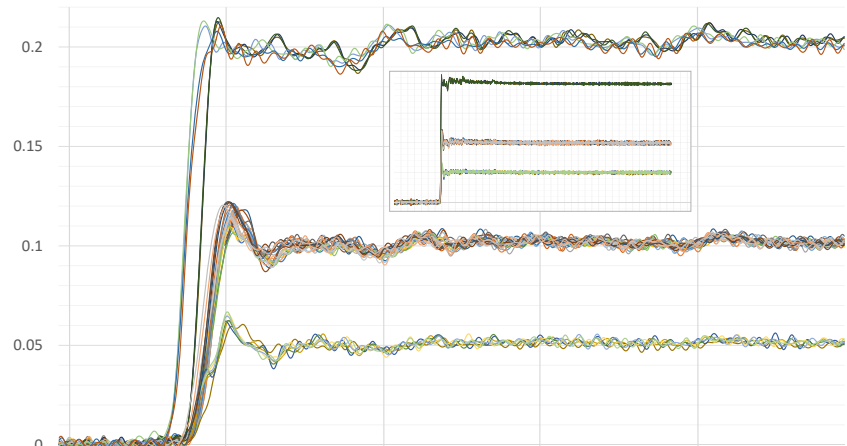
Low-invasive contact probing of a microwave transmission line is challenging because any addition of conductor material (let alone circuitry) will add capacitance and disturb the line geometry and line impedance at the point of contact. However, if the additional loading of the probe is firstly minimized and then made consistent at all frequencies of interest, the overall impact of probing will be a small reduction of signal amplitude at the probe tip. Critically, this is not a change of wave or pulse shape or its relative spectral content and phases. A subsequent adjustment of probe or instrument gain, or scaling of a measurement result, can then compensate for the small amplitude reduction at the point of measurement. The result is excellent pulse fidelity and consistency as shown in the graphs below.

The 900 Series low-impedance, single-ended passive probes are suited to applications up to 9 GHz and transition times down to around 40 ps. Probe tip impedance lies between 1 k Ω and 200 Ω and all have a very low parallel input capacitance of typically 0.3 pF (0.4 pF max.)

Designed for reliability

Low-cost, highly repeatable, very robust and high-integrity coplanar microwave design and screening are all simultaneously achieved through within-substrate assembly of components and edge-of-substrate assembly of test pins and connectors.

Note: PicoConnect 900 Series probes are not designed to be used as launcher probes. These probes are intended as low-invasive measurement devices for browsing of already terminated transmission lines. This purpose is distinct from launcher probes, which are intended to terminate an unterminated transmission line in a measurement or signal injection.



PicoConnect passive probe family pulse shapes – first 2 ns (inset 17 ns)
(Corrected TDT using PicoScope 9311 20 GHz TDT/TDR sampling oscilloscope relative to reference through-path)

Specifications – RF, microwave and pulse probes

Model	911	912	913	914	915	916
Nominal division ratio	20:1		10:1		5:1	
Bandwidth (-3 dB) ^[4]	4 GHz		4 GHz		5 GHz	
Max. usable data rate (fundamental)	8 Gb/s		8 Gb/s		10 Gb/s	
Max. usable data rate (3rd harmonic)	2.6 Gb/s		2.6 Gb/s		3.3 Gb/s	
Max. usable data rate (5th harmonic)	1.6 Gb/s		1.6 Gb/s		2 Gb/s	
Transition time	87.5 ps		87.5 ps		70 ps	
Probe tip impedance (nominal)	960 Ω		440 Ω		230 Ω	
Probe tip capacitance (typical)	0.3 pF					
Probe tip capacitance (maximum)	0.4 pF					
Return loss for probed line	< -10 dB typ.		< -12 dB typ.		< -14 dB typ.	
	All probes < -18 dB typical for frequency < 1.0 GHz.					
Continuous voltage	14 V AC RMS	14 V RMS	10 V AC RMS	10 V RMS	8 V AC RMS	8 V RMS
DC blocking voltage (max.) ^[1]	25 V	–	25 V	–	25 V	–
Peak voltage ^[2]	≤ 25 V					
Coupling ^[1]	AC	DC	AC	DC	AC	DC
Low-frequency cut-off (-3 dB)	40 kHz	–	80 kHz	–	150 kHz	–
Flatness (±0.5 dB) ^[5]	±0.5 dB 120 kHz to 2 GHz	±0.5 dB DC to 2 GHz	±0.5 dB 240 kHz to 2 GHz	±0.5 dB DC to 2 GHz	±1.0 dB 450 kHz to 2 GHz	±1.0 dB DC to 2 GHz
Output impedance ^[3] (for test node impedance 25 Ω)	717 Ω		245 Ω		205 Ω	
Additive voltage noise @ 23 °C	3.4 nV/√Hz		2.0 nV/√Hz		1.7 nV/√Hz	

Specifications – gigabit digital probes

Model	921	922	923	924	925	926
Nominal division ratio	20:1		10:1		5:1	
Bandwidth (-3 dB) ^[4]	6 GHz		7 GHz		9 GHz	
Max. usable data rate (fundamental)	12 Gb/s		14 Gb/s		18 Gb/s	
Max. usable data rate (3rd harmonic)	4 Gb/s		4.6 Gb/s		6 Gb/s	
Max. usable data rate (5th harmonic)	2.4 Gb/s		2.8 Gb/s		3.6 Gb/s	
Transition time	58.3 ps		50 ps		38.8 ps	
Probe tip impedance (nominal)	515 Ω		250 Ω		220 Ω	
Probe tip capacitance (typical)	0.3 pF					
Probe tip capacitance (maximum)	0.4 pF					
Return loss for probed line	< -13 dB typ.		< -15 dB typ.		< -15 dB typ.	
	All probes < -18 dB typical for frequency < 1.0 GHz.					
Continuous voltage	4.75 V AC RMS	4.75 V RMS	3.5 V AC RMS	3.5 V RMS	3.5 V AC RMS	3.5 V RMS
DC blocking voltage (max.) ^[1]	25 V	–	25 V	–	25 V	–
Peak voltage ^[2]	≤ 25 V					
Coupling ^[1]	AC	DC	AC	DC	AC	DC
Low-frequency cut-off (-3 dB)	70 kHz	–	140 kHz	–	160 kHz	–
Flatness (±0.5 dB) ^[5]	±1 dB 210 kHz to 2 GHz	±1 dB DC to 2 GHz	±0.5 dB 420 kHz to 2 GHz	±0.5 dB DC to 2 GHz	±0.5 dB 480 kHz to 2 GHz	±0.5 dB DC to 2 GHz
Output impedance ^[3] (for test node impedance 25 Ω)	54 Ω		48 Ω		187 Ω	
Additive voltage noise @ 23 °C	0.9 nV/√Hz		0.9 nV/√Hz		1.6 nV/√Hz	

Specifications – all models

Environment	
Operating temperature range	0 to 50°C
Storage temperature range	-20 to +70°C
Temperature range for stated specifications	15 to 30°C
Operating humidity range	5 to 80 %RH non-condensing
Storage humidity range	5 to 95 %RH non-condensing
Altitude range	up to 2000 m
Pollution degree	2
Safety approvals	EN 61010-031
EMC approvals	Not applicable
Environmental approvals ^[6]	WEEE, RoHS
General	
Output connector (probe head)	SMA(f): maximum torque 0.45 Nm
Supplied cable	TA312 60 cm SMA(m-m) precision blue-sleeved high-flex 085 microwave coaxial cable
Supplied accessories	TA315 Pack of replacement probe tips; two coils of solder-in gold-plated wire TA313 SMA-to-BNC interseries adaptor (with RF, microwave and pulse models only)
Dimensions (probe head)	68 x 19 x 11 mm
Nominal probe tip pitch	5 mm
Weight	5 g

All specifications are subject to change without notice.

[1] CAUTION: When using AC coupled probes, to avoid damage to the connected instrument ensure that it can withstand transient voltage equal to the DC bias of the test node divided by the nominal probe ratio.

[2] CAUTION: To avoid damage to the probe, RMS voltage over the pulse period must remain within specified probe rating.

[3] Probes having unmatched output impedance will not absorb pulse aberrations that reflect off mismatch at the connected instrument input. Pulse fidelity and flatness are therefore more dependent on good instrument match.

[4] Bandwidth (BW) is calculated from measured transition time (tR) as $BW \text{ (GHz)} = 350 / tR \text{ (ps)}$.

[5] Typical performance

[6] See PicoConnect 900 EU Declaration of Conformity for details.



PicoConnect 900 Series single probe

- PicoConnect 900 Series probe head
- Precision 60 cm 085 low-loss cable
- SMA-to-BNC adaptor (with RF and Microwave models only)
- Quick Start Guide
- Set of replacement gold-plated probe and ground tips
- Two coils of solder-in gold-plated wire
- Storage and carry case



Two probes effectively free!

PicoConnect 900 Series six-probe kit

- Six PicoConnect 900 Series probe heads
- Two precision 60 cm 085 low-loss cables
- Two SMA-to-BNC adaptors (with RF and Microwave models only)
- Quick Start Guide
- Set of replacement gold-plated probe and ground tips
- Two coils of solder-in gold-plated wire
- Storage and carry case

The best compromise of impedance, division ratio and coupling is available for your test.

The impact upon a measurement of each probe loading can be determined through comparison.

Use the PicoConnect 900 Series probes with any oscilloscope that supports standard 50 Ω probes, including these Pico products:



PicoScope 9400 SXRT0
Sampler-extended real-time oscilloscopes 5 to 16 GHz



PicoScope 9300 Series
25 GHz sampling oscilloscopes



PicoScope 6000 Series
Up to 8 channels, Ultra-deep 4 GS memory buffer, Gigabit MSO channels

Ordering information

Order code	Description
TA274	PicoConnect 911 20:1 AC-coupled 4 GHz RF, microwave and pulse passive probe
TA275	PicoConnect 912 20:1 DC-coupled 4 GHz RF, microwave and pulse passive probe
TA278	PicoConnect 913 10:1 AC-coupled 4 GHz RF, microwave and pulse passive probe
TA279	PicoConnect 914 10:1 DC-coupled 4 GHz RF, microwave and pulse passive probe
TA282	PicoConnect 915 5:1 AC-coupled 5 GHz RF, microwave and pulse passive probe
TA283	PicoConnect 916 5:1 DC-coupled 5 GHz RF, microwave and pulse passive probe
TA272	PicoConnect 921 20:1 AC-coupled 6 GHz gigabit passive probe
TA273	PicoConnect 922 20:1 DC-coupled 6 GHz gigabit passive probe
TA276	PicoConnect 923 10:1 AC-coupled 7 GHz gigabit passive probe
TA277	PicoConnect 924 10:1 DC-coupled 7 GHz gigabit passive probe
TA280	PicoConnect 925 5:1 AC-coupled 9 GHz gigabit passive probe
TA281	PicoConnect 926 5:1 DC-coupled 9 GHz gigabit passive probe
PQ067	PicoConnect 910 Kit: all six 4 to 5 GHz RF, microwave and pulse probe head models with cables
PQ066	PicoConnect 920 Kit: all six 6 to 9 GHz gigabit probe head models with cables
TA264	30 cm unsleeved 50 Ω, SMA(m-m) flexible 085 microwave cable, 1.1 dB @ 13 GHz
TA265	30 cm sleeved 50 Ω, SMA(m-m) flexible 085 microwave cable, 1.3 dB @ 13 GHz
TA312	60 cm sleeved 50 Ω, SMA(m-m) flexible 085 microwave cable, 2.2 dB @ 13 GHz
TA313	Inter-series adaptor SMA(f) to BNC(m), 50 Ω, 3 GHz
TA314	Inter-series adaptor SMA(f) to N(m), 50 Ω, 18 GHz
TA315	Kit of replacement gold-plated probe tips and solder-in wire

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