TA1000B-x

Fast, Very Low Noise Pulse / Timing Preamplifier

User Manual

Grünwalder Weg 28a, D-82041 Oberhaching
Germany

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Warranty

Equipment manufactured by FAST ComTec GmbH is warranteed against defects in materials and workmanship for a period of twelve months from date of shipment, provided that the equipment has been used in a proper manner as detailed in the instructions manuals. During the warranty period, repairs or replacement will be made to FAST ComTec's discretion on a return to factory basis. The transportation costs, including insurance to FAST ComTec is the responsibility of the customer except for defects discovered within 30 days after receipt of the equipment, where shiping expense will be paid by FAST ComTec.

The information in this manual describes the hardware and the software as accurately as possible, but is subject to change without notice.

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1. Description

The TA1000B-x comprises a series of fast, very low noise preamplifiers with model dependent voltage gains of 10, 50, 100 or 200 V/V and corresponding small signal bandwidths of 710, 1000, 950 or 400 MHz respectively.

A unique feature for such high speed amplifiers is DC coupling. DC coupling avoids count rate effects due to non DC balanced pulse trains and the corresponding charging of coupling capacitors. This is particularly important when bursts of pulses may occur.

Type	Nominal Gain [V/V]	Nominal Gain [dB]	Small Signal Band-width (-3dB)	Gain Flatness	Peaking (100ps Rise Time Input Pulse)	Noise Figure (100MHz)	Input Referred Broadband Noise (DC ... 12.5GHz)		Input Referred LF Noise (20Hz ... 1MHz)
			(0) (1)	(0) (1)	(0) (2)		(3) (4)	(4)	(5)
TA1000B-10	10	20dB	710MHz	0.00dB	6%	8dB	51.2µV_{rms}	0.224mV_{p-p}	0.3µV_{rms}
TA1000B-10 BWL(6)	10	20dB	170MHz	0.00dB	0%		30.2µV_{rms}	0.124mV_{p-p}	
TA1000B-50	50	34dB	1000MHz	0.22dB	9%		57.8µV_{rms}	0.541mV_{p-p}	0.5µV_{rms}
TA1000B-50 BWL(6)	50	34dB	245MHz	0.00dB	0%		36.6µV_{rms}	0.509mV_{p-p}	
TA1000B-100	100	40dB	950MHz	0.12dB	8%		55.9µV_{rms}	0.542mV_{p-p}	12.3µV_{rms}
TA1000B-100 BWL(6)	100	40dB	245MHz	0.00dB	0%		34.2µV_{rms}	0.318mV_{p-p}	
TA1000B-200	200	46dB	400MHz	0.00dB	0%		31.2µV_{rms}	0.331mV_{p-p}	13.6µV_{rms}
TA1000B-200 BWL(6)	200	46dB	110MHz	0.00dB	0%		23.1µV_{rms}	0.223mV_{p-p}	

(0) Simulation Results
(1) Signal input: sine wave = 200mVeff / "nominal Gain"
(2) Output Pulse Height approx. 200mVp-p, Input Rise Time 100ps
(3) defined as RMSΔ = σ = standard deviation, ref. scope pictures of output noise voltages below
(4) in 40 minutes accumulated with a 12.5GHz sampling head, ref. scope pictures of output noise voltages below
(5) measured with a HP3455A True RMS Voltmeter, this is mostly the 1/f noise
(6) BWL = Bandwidth limited option (with improved noise performance)

Fig. 1.1: Comparison chart

Basically the TA1000B is a non inverting, closed loop, voltage mode, one- or two-stage operational amplifier design.

Input offset adjustment is provided. The input related adjustment range is approximately >±5 mV.

Each model is available with a bandwidth limited (BWL) option which further reduces the noise floor.

WARNING: The amplifier has no thermal shutdown. Thus, be careful when connecting the output to loads less than 50 Ohms (**do not shorten the output!**).

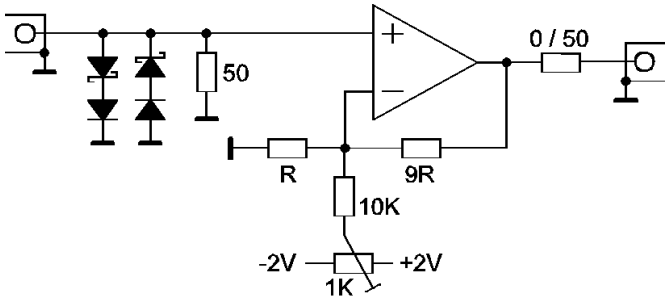


Fig. 1.2: TA1000B-10 simplified schematic

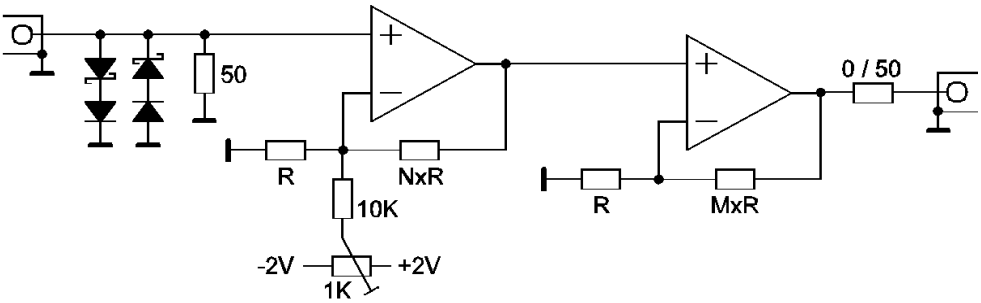


Fig. 1.3: TA1000B-50 / -100 / -200 simplified schematic

Typical applications for the TA2000B are:

- Pre-amp for ultra fast detectors (MCP, PMT, …)
- Oscilloscope and transient recorder pre-amp
- High precision Time-of-Flight
- Photon-/Ion-counting
- Wideband signal processing

2. Specifications

2.1. Absolute maximum ratings

Supply:	(100 ms max.) ..... 25 V
Signal input:	..... ± 1.8 V .....± 140 mA
Input clamping:	(1 schottky + 1 silicon diode drop) .....approx. ± 700 … 900 mV
ESD rating:	.....2300 V HBM .....200 V MM

2.2. Technical data

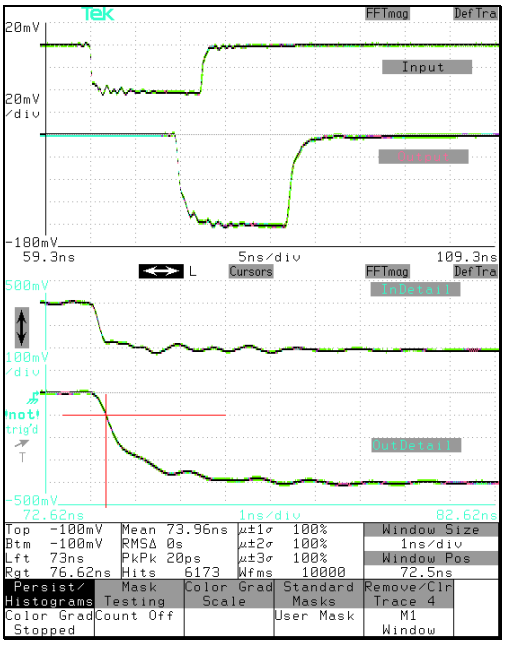
Voltage gain:	TA1000B-10: .....non inverting, 20dB / x10 TA1000B-50: .....non inverting, 34dB / x50 TA1000B-100: .....non inverting, 40dB / x100 TA1000B-200: .....non inverting, 46dB / x200
Input connector:	.....BNC, 50 Ohm, DC coupled .....AC coupling option available
Output connector:	..... BNC, low impedance, DC coupled ..... 50 Ohm output option available
Output voltage:	.....max. ± 1.3 V
Output current:	..... max. ± 150 mA
Slew rate:	TA1000B-10 (2 V step) .....1600 V/µs TA1000B-10 BWL (2 V step) .....530 V/µs
Input offset voltage:	..... max. ± 1.5 mV .....typ. ± 2.0 µV/°C
Input offset adjustment:	..... > ± 5 mV

2.3. Power requirements

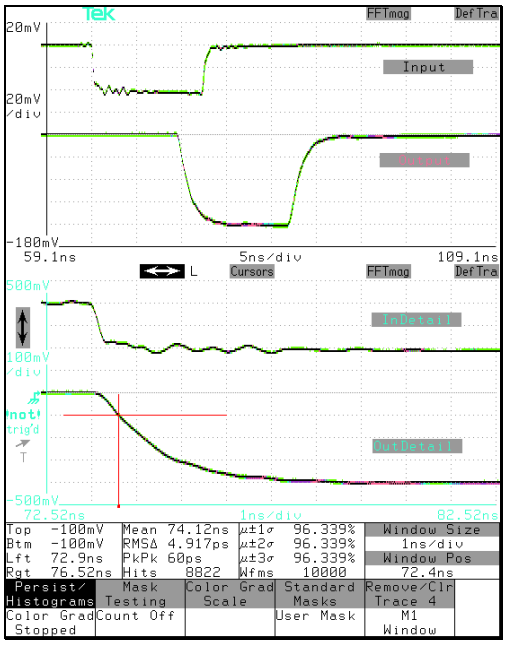
Supply connectoer:	.....2.1 mm center pin
Supply voltage:	.....nominal +12 V_{DC} voltage range: .....+10 … +18 V_{DC} .....false polarity protection
Supply power:	..... 2.5 W

2.4. Diagrams

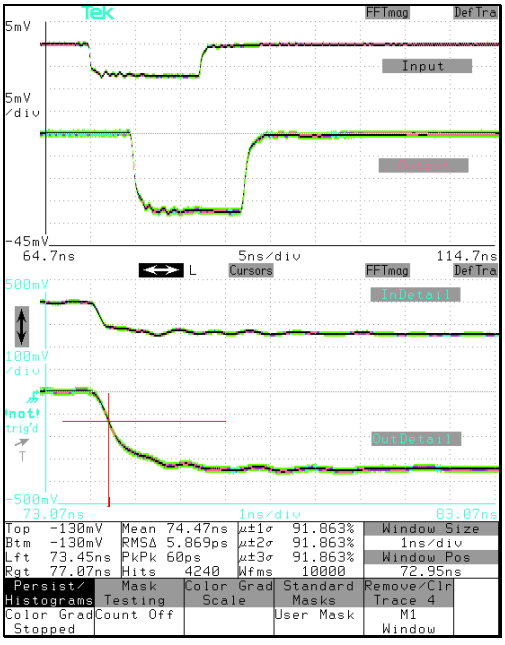
2.4.1. 0 to –400mV falling edge pulse response



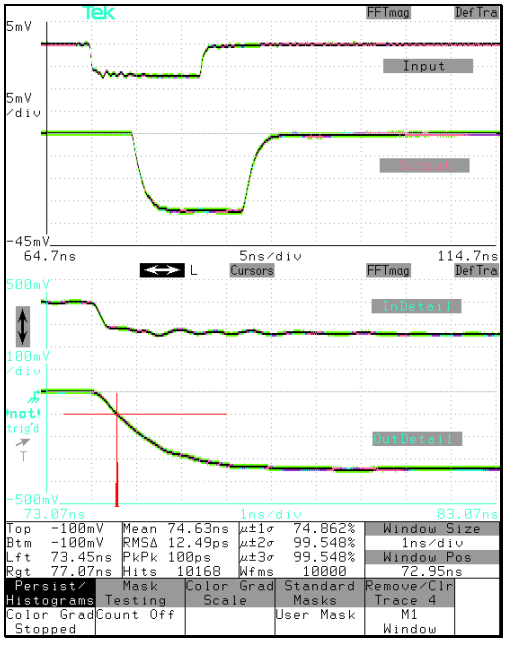
TA1000B-10 (x10), Input 20mV/div, Output 100mV/div



TA1000B-10BWL (x10), In 20mV/div, Out 100mV/div

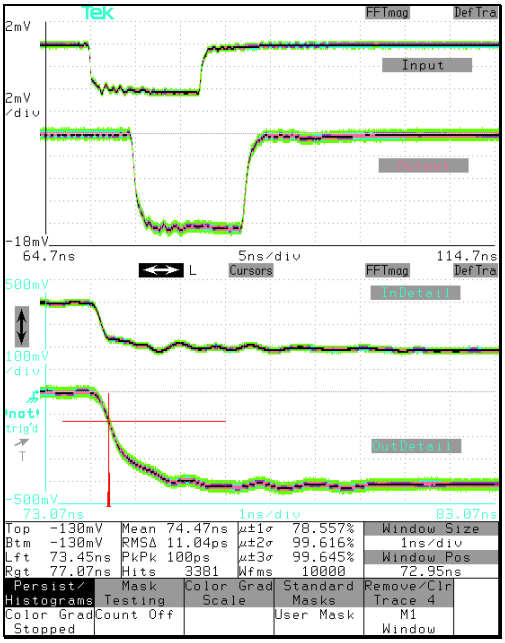


TA1000B-50 (x50), Input 5mV/div, Output 100mV/div

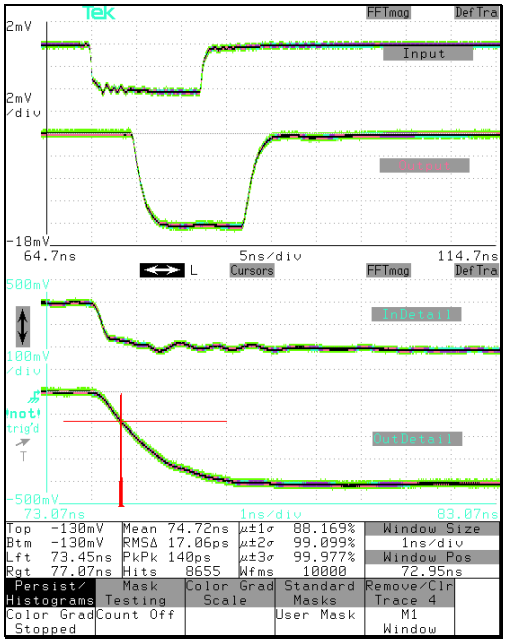


TA1000B-50BWL (x50), In 5mV/div, Out 100mV/div

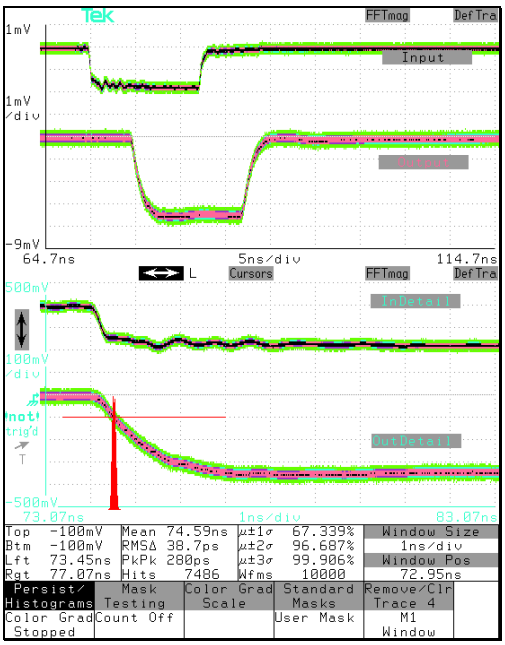
The scope pictures are taken using a TEK11801C digital sampling scope with a SD20 20 GHz loop-through sampling head for input signals and a SD22 12.5GHz low noise sampling head for output signals



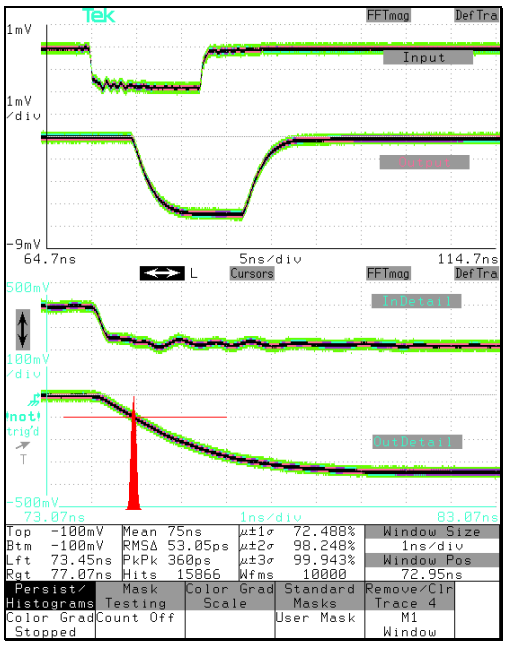
TA1000B-100 (x100), Input 2mV/div, Output 100mV/div



TA1000B-100BWL (x100), In 2mV/div, Out 100mV/div



TA1000B-200 (x200), Input 1mV/div, Output 100mV/div



TA1000B-200BWL (x200), In 1mV/div, Out 100mV/div

The lower window of each plot shows details of the corresponding signals in the upper window. There is also a (red colored) histogram of the output signal jitter at a -100mV or –130mV threshold. The jitter's Peak-to-Peak value is visible at "PkPk" and its standard deviation in the "RMSΔ" readout.

This jitter histogram gives a good indication of the timing accuracy and resolution that can be expected.

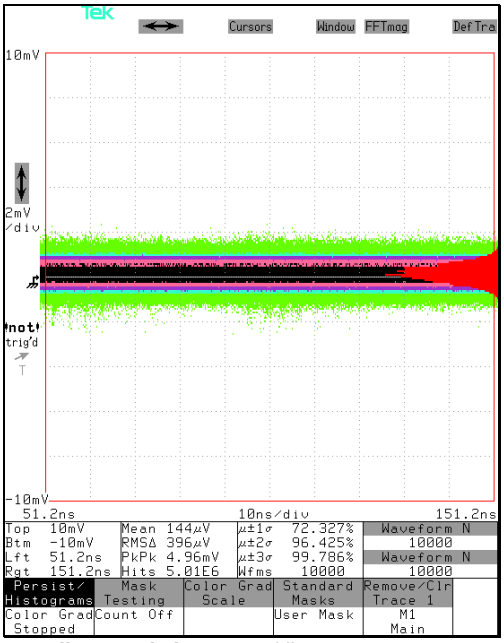
And, one can very well see that the optimum threshold setting for timing measurements is often not at half of the signal's amplitude but at some other level not too far from idle voltage where the slew rate is at maximum.

2.4.2. Max. output broadband noise voltage

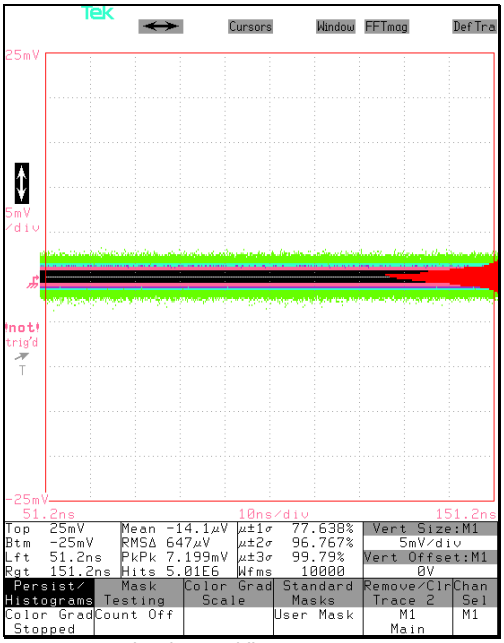
Normally the noise is given input referred, so to speak, it can be compared to the source signal levels. For timing applications it is often more depicting to plot the total output noise of an amplifier.

In the following scope pictures the output noise voltage of our TAx-amplifiers is accumulated over 10,000 waveforms corresponding to about 40 minutes of measurement time. Used was a TEK11801C digital sampling scope with a SD22 12.5GHz sampling head. Thus, the displayed noise voltage is accumulated over a long period and also over the full bandwidth of each amplifier. The TAx's inputs were shortened, i.e. ZSource = 0Ω.

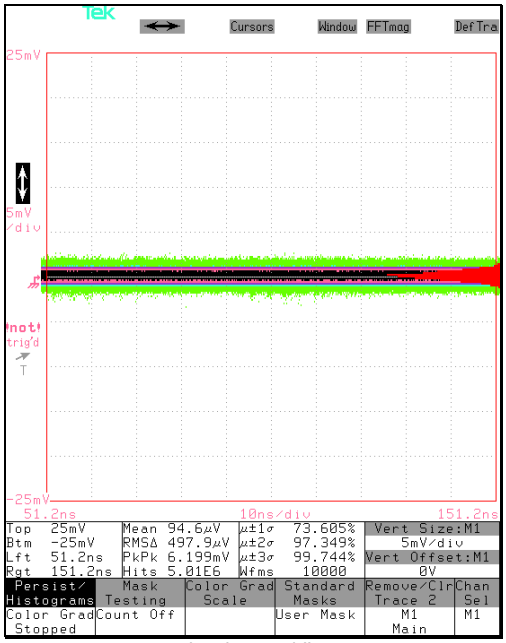
On the right side of each plot you can see a (red colored) histogram of all the voltage samples in the respective picture. This gives the probability distribution of the noise voltage levels. And, you can find some analysis data on the respective voltage distribution: Mean = average value, RMSΔ = σ = standard deviation, PkPk = Peak-to-Peak voltage = max. – min. sample voltage, μ ± 1σ = percentage of samples that fall within ±1 standard deviation of the mean (.±2σ, ±3σ respectively).



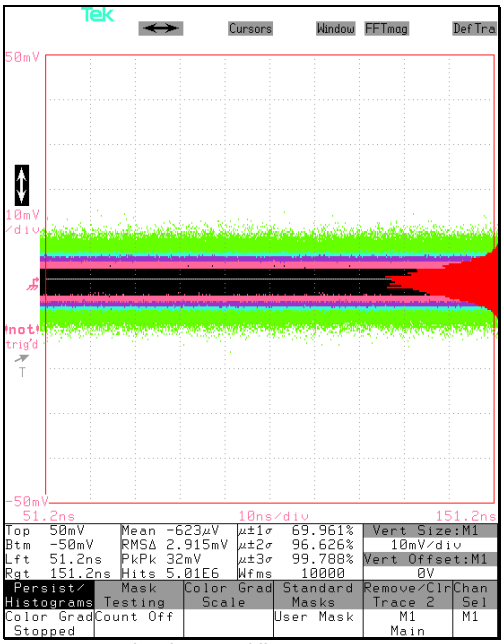
Sampling Head alone, 2mV/div



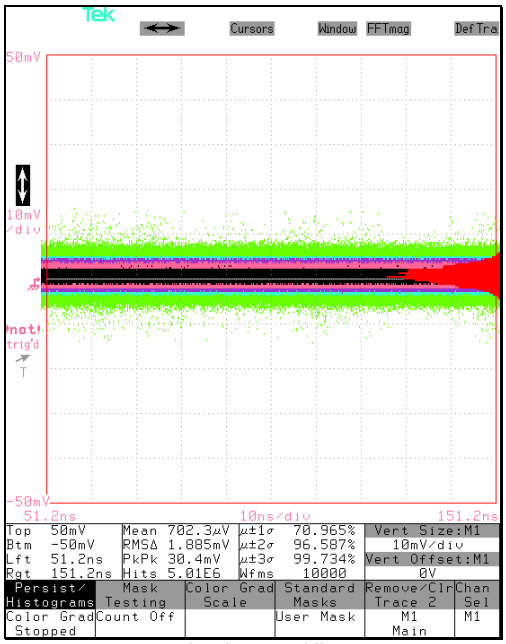
TA1000B-10 (x10), 5mV/div



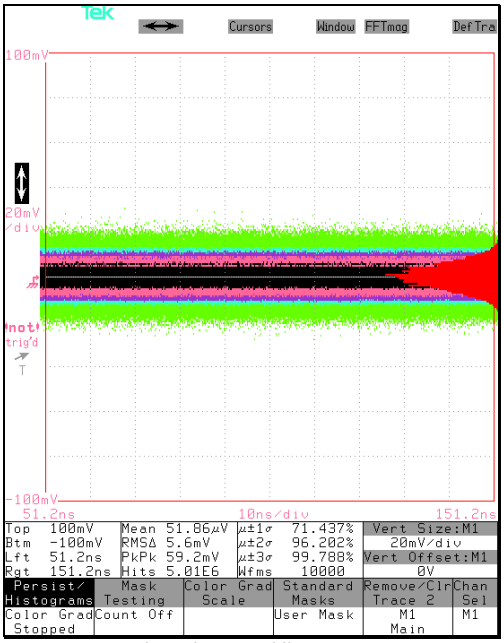
TA1000B-10 BWL (x10), 5mV/div



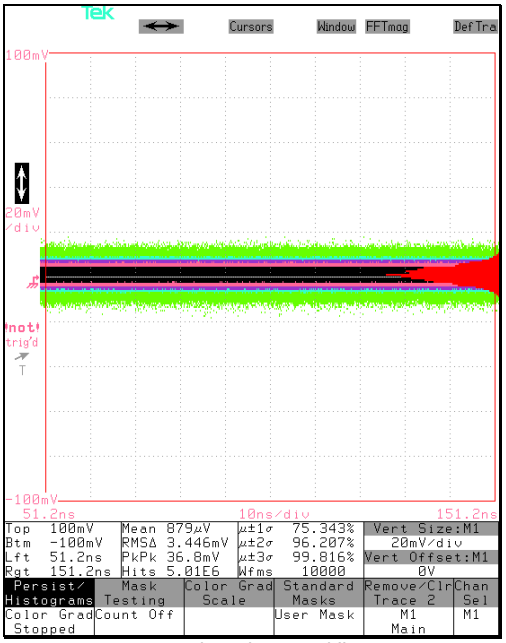
TA1000B-50 (x50), 10mV/div



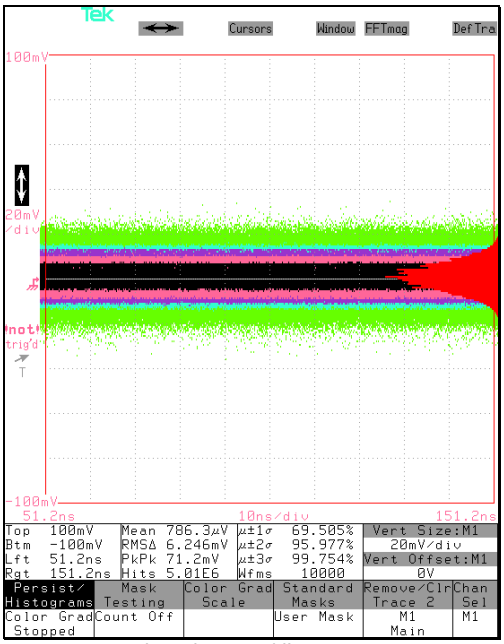
TA1000B-50 BWL (x50), 10mV/div



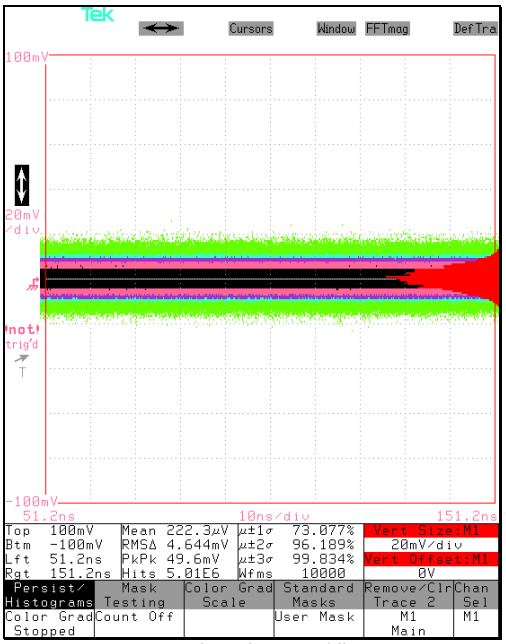
TA1000B-100 (x100), 20mV/div



TA1000B-100 BWL (x100), 20mV/div



TA1000B-200 (x200), 20mV/div



TA1000B-200 BWL (x200), 20mV/div

2.4.3. Simulated frequency response

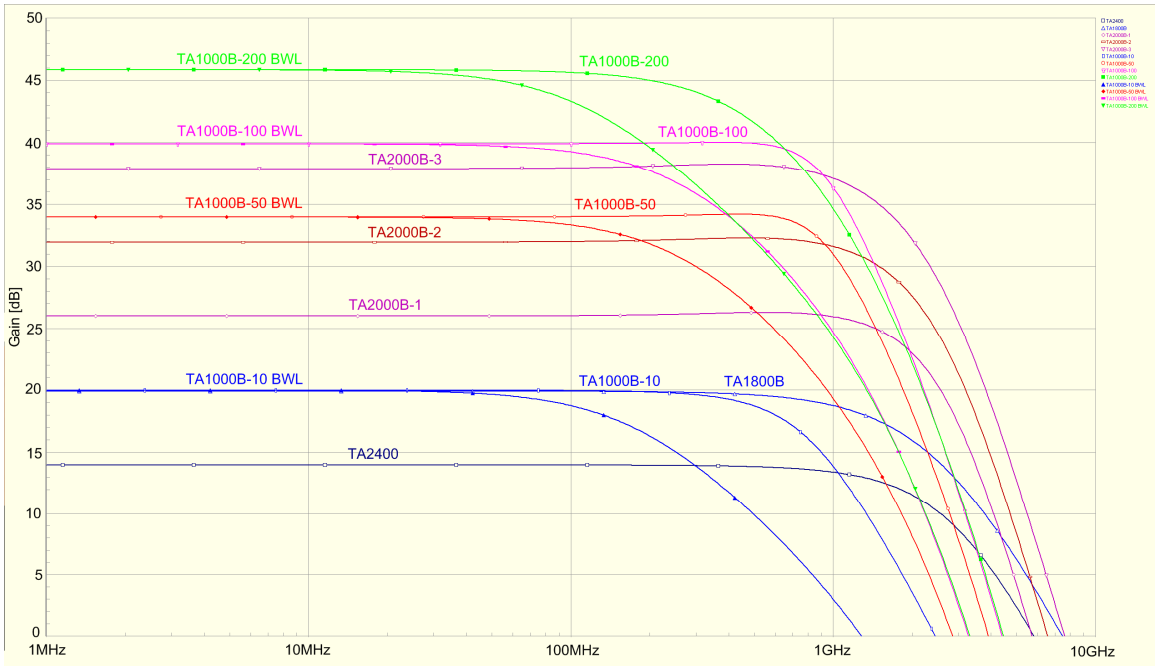


Fig. 2.1: Simulated frequency response of all TAx models

2.5. Metal case

Case material: ..... extruded aluminium sheath, Al Mg Si 0.5
Lid material: ..... die cast, GD-Al Si 12
Size: ..... 65/101 x 60 x 35 mm
Weight: ..... 124 g

2.6. Accessories

- External wall power supply (included)
- L-clips (order no. AB-WL) for wall-/screw-mounting (optional)

2.7. Available options

- **50 Ohm output impedance**
  This improves the output signal quality since reflections from the target device (oscilloscope, multichannel analyzer, etc.) are well terminated at the TA2000's output and do not travel many times back and force over the cable. Thus, distortion of a subsequent pulse is largely avoided.
  This option is particularly recommended when high pulse rates are expected.
  The drawback, of course, is a reduction in the receiving amplitude at the target device by a factor of 2. Or, in other words, the effective voltage gain into a 50Ω load is reduced by a factor of 2 (-6 dB).

- **Input AC coupling**
  An input AC coupling with 100nF can be ordered. This results in a lower frequency cut-off of approx. 32 kHz.

- **Bandwidth Limit**
  A bandwidth limited option is available that further reduces the noise floor (ref. comparison chart for details on the resulting bandwidth and noise).