

Technical Description & Application Notes



TS Companion

Advanced Low Noise Current Amplifier for THz Sensors

THE new TeraSpike Companion is the first commercially available low-noise amplifier specially designed and optimized for THz time-domain spectroscopy applications based on photoconductive detectors and emitters - including of course the full line of Proteemics TeraSpike (TS) microprobes. In contrast to conventional current amplifiers, the TS Companion offers important additional functions that are typically required for THz-TDS-related tasks, including e.g. connections for Tx and Rx devices, an optical alignment mode, a switchable bias function for all inputs as well as a fully electronic control for system integration. A fine selection of amplification in 1–2–4–8 steps per decade (factor-of-two increments) is included for optimal utilization of the maximum possible signal-to-noise ratio in any THz system. As required for operation with fast-scanning THz TDS modules (e.g. TeraFlash Pro, Toptica), it also offers a comfortable bandwidth reserve that ensures unadulterated THz signal detection up to the highest amplification range.

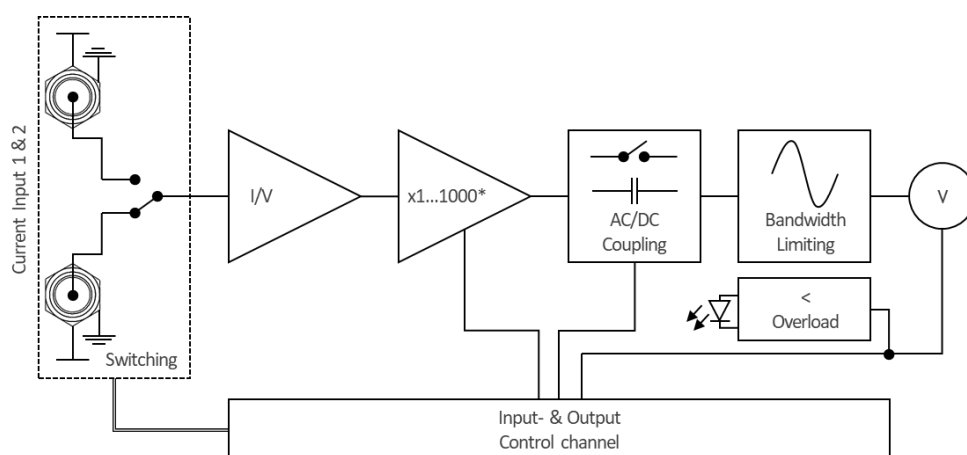
Key Features

- Two input channels for Tx and Rx connection
- Operation mode switchable between optical alignment & THz detection
- Trans-impedance (gain) variable in 1–2–4–8 steps per decade from 1×10^6 to 8×10^8 V/A
- Bandwidth DC/400 Hz to 40 kHz
- Dynamic bias voltage
- Local and remote control options
- Wide operating supply range

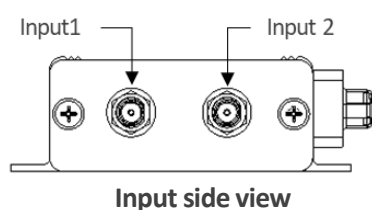
Applications

- Proteemics near-field probe operation including transceiver, emitter, or detector probes
- General Terahertz photoconductive antenna operation
- Photodiode and photomultiplier amplifier
- Multichannel current acquisition system
- Preamplifier for lock-ins, A/D converters, etc.

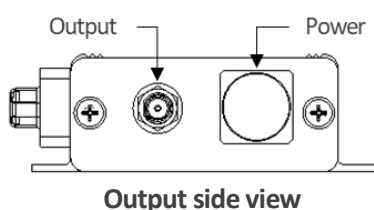
Block Diagram



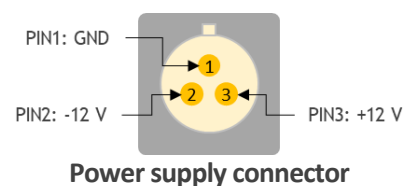
Interface description



Input1: SMA, isolated, jack female
 Input2: SMA, isolated, jack female
 Detector bias output: shield of the input1 SMA & input2 SMA



Output: SMA, jack female



Socket: Lemo series 0B, 3-pin fixed socket
 Plug: Matching parts
 FGG. 0B.303.CLAD52
 Pin 1: GND Pin 2: -12 V Pin 3: +12 V

Specifications

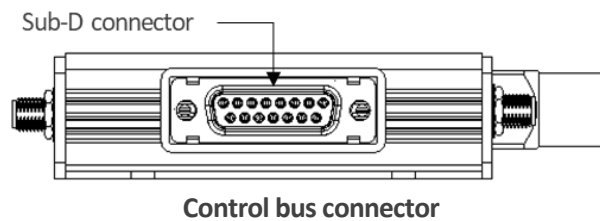
Model	LNA-40k-8E8
Trans-impedance gain [V/A] [†]	$1 \times 10^6 \dots 8 \times 10^8$, 1–2–4–8 steps per decade
-3-dB-Bandwidth [kHz] [†]	40, for all gain settings. Switchable to 0.4
Amplifier output voltage [V]	± 12
Output impedance	Open
Max. output current [mA]	± 40
External bias supply for THz device inputs	± 12 V, max. 120 mA
Indicator LED	On: Overload, Off: Normal operation

Power supply voltage	$\pm 5\text{ V} \dots \pm 14\text{ V}$ (max.), $\pm 12\text{ V}$ (recommended)
Power supply current	Typ. $\pm 50\text{ mA}$
Weight [g]	120
Operating temperature range	$0 \dots 70^\circ\text{C}$

Test conditions: $V_s = \pm 12\text{ V}$, $T_A \approx \text{Room Temperature}$, Load Impedance = $10\text{ M}\Omega$

†Can be customized on request. For further information please contact us at info@protemics.com

Digital Control



Model	LNA-40k-8E8
Control input voltage range LOW bit	$-12\text{ V} \dots 0.8\text{ V}$, recommended: GND/0 V
Control input voltage range HIGH bit	$2.4\text{ V} \dots +12\text{ V}$, recommended: 5 V
Control input current range	$\pm 1\text{ }\mu\text{A}$ @ 0.8 V (LOW) ... 2.4 V (HIGH)

Pin	Description
Pin 1	Signal output (connected to SMA)
Pin 2	Supply +12 V
Pin 3	Digital control input: AC/DC
Pin 4	Digital control input: Gain
Pin 5	Digital control input: Gain
Pin 6	Digital control input: Controls Input1
Pin 7	NC
Pin 8	Digital control input: Controls Input2
Pin 9	GND
Pin 10	NC
Pin 11	Digital control input: Gain
Pin 12	Digital control input: Gain
Pin 13	Channel for supplying voltage to Input1
Pin 14	Digital control input: Input1/Input2
Pin 15	Channel for supplying voltage to Input2

Remote Control Mode

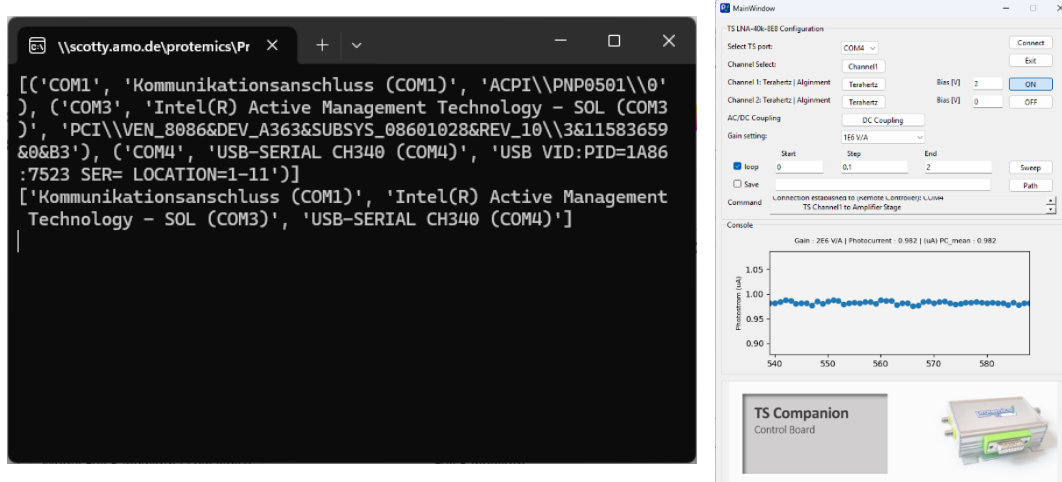
In remote mode the device is controlled using a Sub-D 15-pin interface:

Pin	Function	Mode [Input/Output] Address [LOW/HIGH]: Function
Pin 1	Signal output (connected to SMA)	Output
Pin 2	Supply +12 V	Output
Pin 3	Digital control input: AC/DC	Input: HIGH: AC ... LOW: DC
Pin 4	Digital control input: Gain	see gain selection
Pin 5	Digital control input: Gain	see gain selection
Pin 6	Digital control input: Controls Input1	Input: LOW: GND ... HIGH: Voltage
Pin 7	NC	-
Pin 8	Digital control input: Controls Input2	Input: LOW: GND ... HIGH: Voltage
Pin 9	GND	Input
Pin 10	NC	-
Pin 11	Digital control input: Gain	see gain selection
Pin 12	Digital control input: Gain	see gain selection
Pin 13	Channel for supplying voltage to Input1	Input
Pin 14	Digital control input: Input1/Input2	Input: HIGH: Input1 ... LOW: Input2
Pin 15	Channel for supplying voltage to Input2	Input

Remote Control via Remote Control Plug

Download the Remote Control Software (RemoteControlSoftware_v1.2.zip) from the TS Companion product page on the Proteemics website (www.proteemics.com/product-ts-companion.html). The software is a standalone portable Windows 10 or higher application and does not require installation. Unzip the archive to any folder on a local hard drive of your PC.

Connect the RCP to the (unpowered) LNA, then power the LNA and connect the RCP to your computer via USB. After starting the software a command window and the graphical user interface (GUI) will open (see Figure below).



Command window (left) and GUI (right) for the Remote Control Software.

To connect to the Remote Control Plug select a COM-port in the GUI menu and press the Connect button. The Remote Control Plugs COM port can be seen in the command window “USB-Serial CH340” (e.g.: COM4 in GUI Figure (left)). If any other COM Port is chosen, the software will respond with this message in the Console:

“Most likely not the Remote Controller : COM1”

If the correct COM port is chosen the software will respond with:

“Connection established to (Remote Controller): COM4”

Remote Control Plug GUI commands:

Switch/Control	Function
Select TS port	COM port selection
Connect	Connects to the COM port
Channel 1 : THz Alignment Channel 2 : THz Alignment	In Alignment Mode a 1 V bias voltage is applied to the outer connector of the channel. In this mode you can align the optical excitation spot position on the photoswitch by maximizing the LNA output signal. In THz mode the bias voltage is switched off. In this mode you can do the THz measurement.
Bias [V]	Turns the Bias Voltage ON/OFF. When Alignment Mode is activated the Bias Voltage is set automatically to ON.
Sweep	A Bias Voltage Sweep is performed and plotted according to the [Start : Step : End] settings (Figure 2). If the Save button is toggled the Sweep will be automatically saved in the actual path or in the chosen path.
Path	Save path for the voltage sweep measurement.
Channel: Channel 1 Channel 2	Selection of active LNA input channel.
Mode: AC DC Coupling	The signal is AC coupled or the signal is DC coupled
Amplification:	variable gain from 1×10^6 to 8×10^8 V/A in 1–2–4–8 steps per decade
Command:	LNA response

Manual Control Mode (optional)

In manual mode the device is controlled using the optional manual control plug:

Switch/ Terminal Block	Function	Address/Designation
Switch 1	Input1/Input2	HIGH/LOW
Switch 2	GND/Voltage, to input1	LOW/HIGH
Switch 3	GND/Voltage, to input2	LOW/HIGH
Switch 4	DC/AC	LOW/HIGH
Switch 5	NC	-
Switch 6	NC	-
Switch 7	A0 Gain	see gain selection
Switch 8	A1 Gain	see gain selection
Switch 9	A2 Gain	see gain selection
Switch 10	A3 Gain	see gain selection
Terminal Block	Stable supply +12 V	+12 V
Terminal Block	Stable supply +5 V	+5 V
Terminal Block	Stable supply +1 V	+1 V
Terminal Block	Ground	GND
Terminal Block	Signal output (connected to SMA)	Signal
Terminal Block	V2IN1, Channel for supplying voltage to Input1	V2IN1
Terminal Block	V2IN2, Channel for supplying voltage to Input2	V2IN2
Terminal Block	Ground	GND

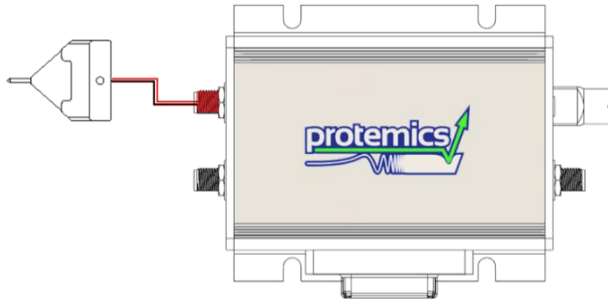
Gain Selection chart:

Gain (V/A)	Pin/Address			
	Pin 11/A1	Pin 4/A0	Pin 12/A3	Pin 5/A2
1×10^6	LOW	LOW	LOW	LOW
2×10^6	LOW	LOW	LOW	HIGH
4×10^6	LOW	LOW	HIGH	LOW
8×10^6	LOW	LOW	HIGH	HIGH
1×10^7	LOW	HIGH	LOW	LOW
2×10^7	LOW	HIGH	LOW	HIGH
4×10^7	LOW	HIGH	HIGH	LOW
8×10^7	LOW	HIGH	HIGH	HIGH
1×10^8	HIGH	LOW	LOW	LOW
2×10^8	HIGH	LOW	LOW	HIGH
4×10^8	HIGH	LOW	HIGH	LOW
8×10^8	HIGH	LOW	HIGH	HIGH

Typical Application Schematics

Some typical configuration examples for using the TeraSpike Companion in combination with TeraSpike microprobes are depicted in the following. Pin / Switch settings that need to be modified are marked in bold in the tables below.

Scheme 1: Probe Alignment



In this scheme, the probe is biased with an externally supplied voltage and the generated photo-current is amplified by the TeraSpike Companion. This scheme is typically used for the probe alignment of a probe-beam to the TeraSpike's photo-switch. The bias voltage is supplied to the probe by TeraSpike Companion's input connector outer shield (red channel for bias) via pin 13 (for input1) or 15 (for input2). For the TeraSpike Companion to operate in this scheme the following control address needs to be given at 15 pins Sub-D connector.

Control Address for TeraSpike Companion in remote control mode, where input1 is used for probe alignment

Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Address	*	*	LOW	Gain*		HIGH	-	LOW	GND	-	Gain*		Vbias	HIGH	*

**for more details please refer to, the remote control mode table*

Switch status for TeraSpike Companion in manual control mode, where input1 is used for probe alignment

Switch/Terminal	1	2	3	4	5	6	7	8	9	10	Terminal	V2IN1
Switch Status	I	I	O	O	-	A0	A1	A2	A3			Supply +1 V externally*

**for more details please refer to, the manual control mode table*

Scheme 2: Terahertz measurement

In this scheme, the TeraSpike microprobes are operating as THz antenna and the resulting current signals are amplified by the TeraSpike Companion. No bias voltage to the probe is required. For the TeraSpike Companion to operate in this scheme the following control address needs to be given at 15 pins Sub-D connector.

Control Address for TeraSpike Companion in remote control mode, where input1 is used for Terahertz signal

Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Address	*	*	HIGH	Gain*		LOW	-	LOW	GND	-	Gain*		*	HIGH	*
*for more details please refer to, the remote control mode table															

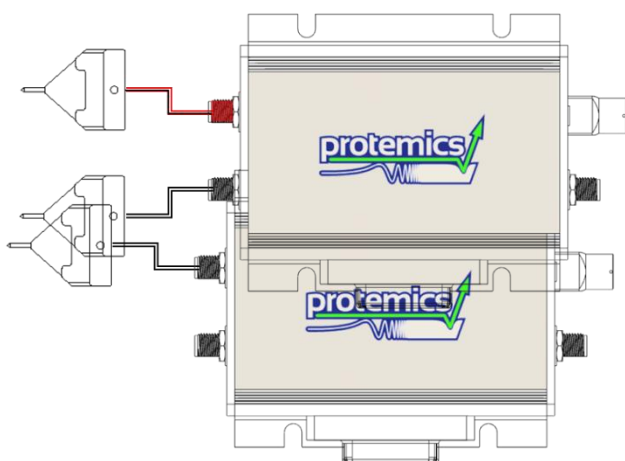
Switch status for TeraSpike Companion in manual control mode, where input1 is used for Terahertz signal

Switch/Terminal	1	2	3	4	5	6	7	8	9	10	Terminal	V2IN1		
Switch Status	I	O	O	I	-	A0	A1	A2	A3			X		

**for more details please refer to, the manual control mode table*

NOTE: If a user wants to use input2 of the TeraSpike Companion instead of input1, the necessary changes need to be done as given in the remote control mode table and manual control mode table depending on the mode of operation.

Scheme 3: Transceiver operation



In this scheme, the input1 of TeraSpike Companion is biasing the probe for Terahertz generation, while the input2 is used for measuring the Terahertz signal. For the TeraSpike Companion to operate in this scheme the following control address needs to be given at 15 pins Sub-D connector.

Control Address for TeraSpike Companion in remote control mode, where input1 is used for biasing the probe and input2 is for measuring the Terahertz signal

Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Address	*	*	HIGH	Gain*		HIGH	-	LOW	GND	-	Gain*		Vbias	LOW	*
*for more details please refer to, the remote control mode table															

Switch status for TeraSpike Companion in manual control mode,
where input1 is used for biasing the probe and input2 is for measuring the Terahertz signal

Switch/Terminal	1	2	3	4	5	6	7	8	9	10	Terminal	V2IN1
Switch Status	O	I	O	I	-		A0	A1	A2	A3		Supply +1 V externally*
*for more details please refer to, the manual control mode table												

Annotations: I: Logic HIGH, O: Logic LOW, X: Don't care

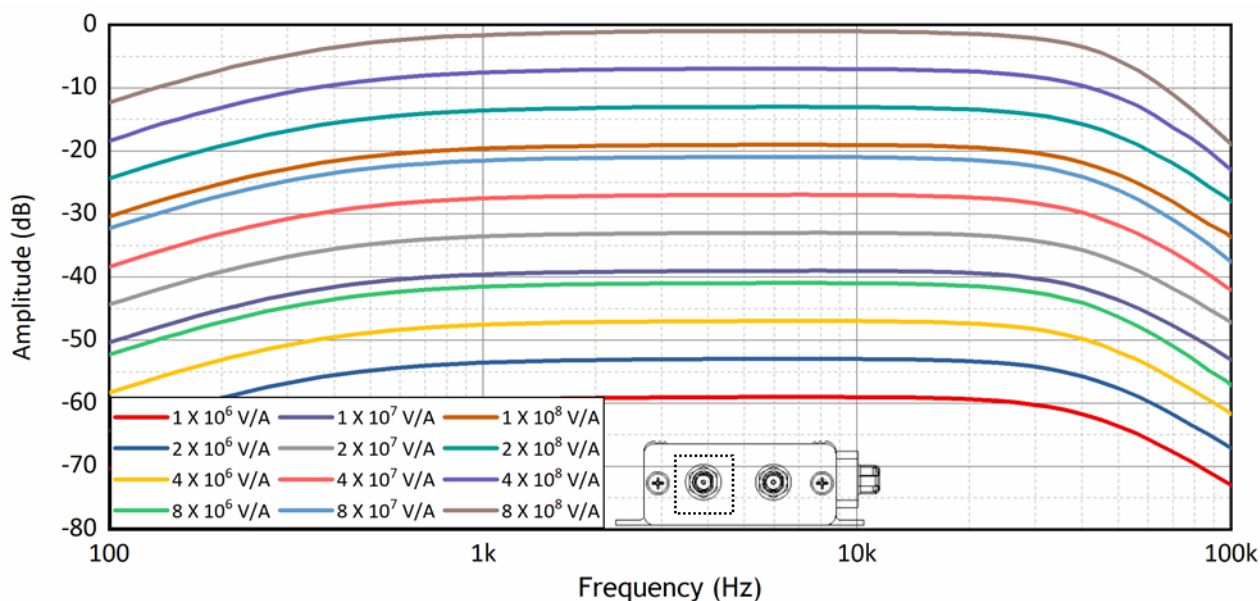
NOTE: For Transceivers probe alignment, please refer to Scheme1 of TeraSpike Companion.

Have more questions about TeraSpike Companion configurations? please feel free to contact us at info@protemics.com

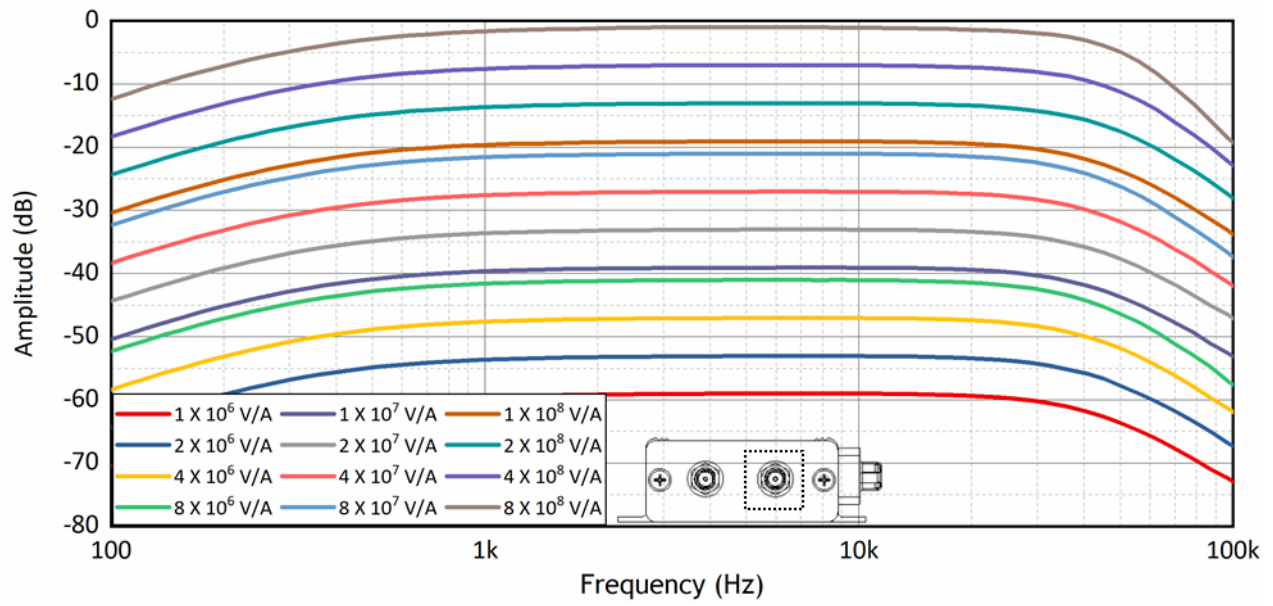
Typical Characteristics

At $V_{S+} = +12\text{ V}$, $V_{S-} = -12\text{ V}$, $R_L = 10\text{ M}\Omega$, $T_A \approx \text{Room Temperature}$.

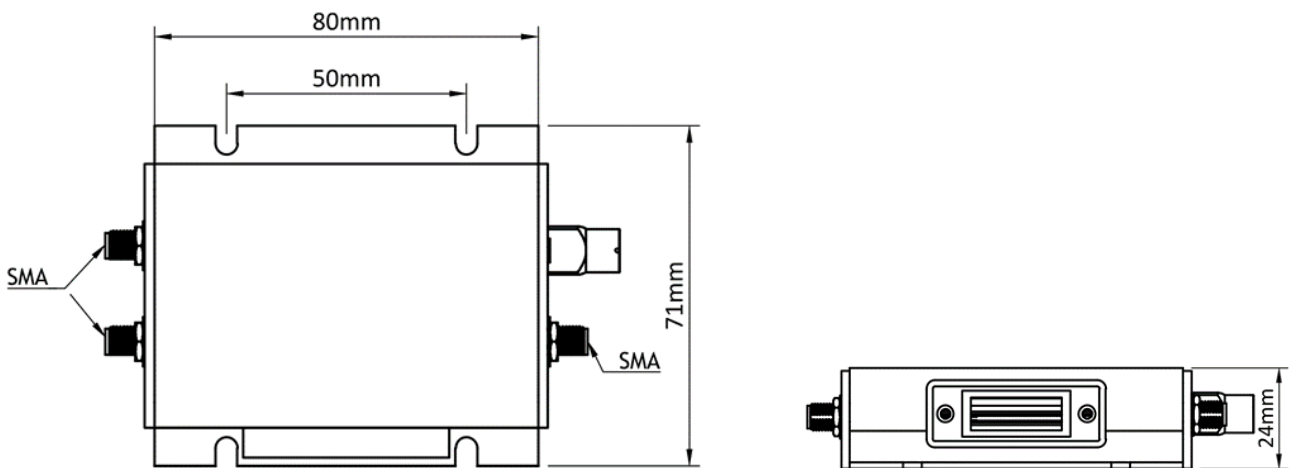
The below graph shows the AC characteristics of input 1:



The below graph shows the AC characteristics of input 2:



Dimensions



Accessory



Remote Control Plug (RCP)

EU Konformitätserklärung EU Declaration of Conformity

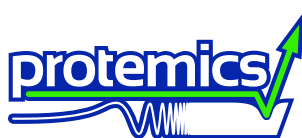
1. Gerätetyp/Produkt
Apparatus model/Product TeraSpike Companion
2. Name und Anschrift des Herstellers
Name and address of the manufacturer Protemics GmbH
Otto-Blumentahl Strasse 25
52074 Aachen
3. Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller. *This declaration of conformity is issued under the sole responsibility of the manufacturer.*
4. Gegenstand der Erklärung
Object of the declaration TeraSpike Companion
5. Der oben beschriebene Gegenstand der Erklärung erfüllt die einschlägigen Harmonisierungsrechtsvorschriften der Union.
The object of the declaration described above is in conformity with the relevant Union harmonisation legislation.

RICHTLINIE 2014/30/EU DES EUROPÄISCHEN PARLAMENTS UND DES RATES vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit

DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility
6. Angabe der einschlägigen harmonisierten Normen, die zugrunde gelegt wurden, einschließlich des Datums der Norm, oder Angabe anderer technischer Spezifikationen, für die die Konformität erklärt wird, einschließlich des Datums der Spezifikation:
References to the relevant harmonised standards used, including the date of the standard, or references to the other technical specifications, including the date of the specification, in relation to which conformity is declared:

DIN EN 55032:2016-02; VDE 0878-32:2016-02 Elektromagnetische Verträglichkeit von Multimediageräten und -einrichtungen - Anforderungen an die Störaussendung (CISPR 32:2015); Deutsche Fassung EN 55032:2015

DIN EN 55035:2018-04; VDE 0878-35:2018-04 Elektromagnetische Verträglichkeit von Multimediageräten - Anforderungen zur Störfestigkeit (CISPR 35:2016, modifiziert); Deutsche Fassung EN 55035:2017
7. Nicht zutreffend.
No applicable.
8. Zusatzangaben
Additional information --



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