linWave Measurement Device Instruction Manual

Instruction Manual

Revision 2024-01

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1. linWave Instruction Manual

This instructions manual applies to the measurement device with code *linWave_1002*.

Read the instructions manual before the first use of the product and follow the instructions to ensure safe usage of the product.

1.1. Original Instructions

The original instructions are written in English language and are verified by Vallen Systeme GmbH.

1.2. Information Provided in the Manual

The information provided in the instruction manual shall enable an operator a safe storage, transportation, installation, and operation of the device.

1.3. Information Provided in Other Resources

The linWave Operation Manual describes the usage of the linWave acoustic emission measurement device with a focus on the Acquisition and Analysis software.

The technical specifications of a linWave device are summarized in the linWave Device Specification.

Accessories such as cables, sensors, magnetic holders, etc. are specified and described in the data sheets and summarized in the Accessories for Acoustic Emission Systems document.

1.4. Intended Audience

This instructions manual is intended for qualified personnel. Qualified personnel have one or more of the listed characteristics:

- have an appropriate technical education.
- can recognize the safety of a linWave device.
- have been trained to operate a linWave device.
- hold a valid certification according to ISO 9712, ASNT or any other comparable standard or standardization organization.

Furthermore, such personnel know regulations concerning employment protection and on-the-job safety.

2. Contact Information

Vallen Systeme GmbH is the manufacturer of Acoustic Emission measurement systems and accessories for acoustic emission testing.


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Information about Vallen Systeme GmbH and the products can be found at www.vallen.de.

3. Regulatory Information

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4. Safety Notices

The following safety notice(s) are used in this manual.

NOTICE

A NOTICE notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a NOTICE notice until the indicated conditions are fully understood and met.

5. Safety Symbols

No safety symbols are used on the device.

6. Important Information for Your Safety

Read these instructions carefully and follow them to safely operate the equipment and to maintain safety throughout its usage. Always make sure that an equipment is used in the intended way. Keep the instructions manual available for later usage.

Do not operate damaged equipment. Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, remove power and do not use the product until safe operation can be verified by service-trained personnel. If necessary, return the product to a Vallen Systeme GmbH sales and service office for service and repair to ensure that safety features are maintained.

Only use accessories that are approved by Vallen Systeme GmbH.

Always make sure that you comply with all regulations at the site of installation of the device.

A linWave device must be installed and used in non-hazardous areas. Do not operate a linWave device in an explosion hazardous area.

7. Important Handling Information

NOTICE

Impaired Ingress Protection

Ingress protection requirements are only met in mated condition. Without sensors and LAN connected, the linWave device is not water resistant and IP67 rating is not given.

How to Avoid Damaging the linWave Device

Only expose the linWave device to harsh environment in mated condition, meaning with AE sensors connected and LAN connection established.

Do not expose the device to dirt and humidity or submerse it in a liquid with open connectors.

What to do in Case of a Damaged Device

In the case a linWave device got exposed to humidity, dirt, or water, send it to Vallen Systeme in order that correct function can be verified and certified by Vallen Systeme.

8. Software and Firmware Updates

Vallen Systeme GmbH releases software updates including new firmware for its measurement devices to (i) add new features, (ii) include product enhancements and (iii) fix software issues. The latest software release can be obtained from www.vallen.de/downloads.

9. Differentiation of Hardware and Terms

spotWave

spotWave is a trademark of Vallen Systeme and the type-designation of a single channel AE measurement system that can be operated via a mobile device. It has an USB interface so it can also be connected to a PC or laptop on which a dedicated Acquisition software can run storing the measurement data to a *.pridb and .*tradb file.

linWave

linWave is a trademark of Vallen Systeme and the type designation of a dual channel AE measurement system that can be integrated into an existing LAN infrastructure and pushes the measurement data over the LAN interface to a host device.

Measurement device vs. measurement system

A spotWave or linWave measurement system consists of the according measurement device (or simply called device) and an AE sensor as well as all necessary accessories for conducting a measurement. The device is the box or chassis which holds the signal processor and logic. It is labelled accordingly as spotWave or linWave device.

10. General Information about the Usage

A linWave device is part of the linWave measurement system (short: linWave system). The dual channel linWave system can be used for measuring acoustic emission. The linWave system consists of Acocustic Emission sensors, the linWave device, and a network switch or router. Power is supplied to the linWave device via power-over-ethernet (PoE). The PoE function is either part of the network switch or router or a stand-alone PoE injector is used. Figure 1 shows a block diagram of the linWave system.

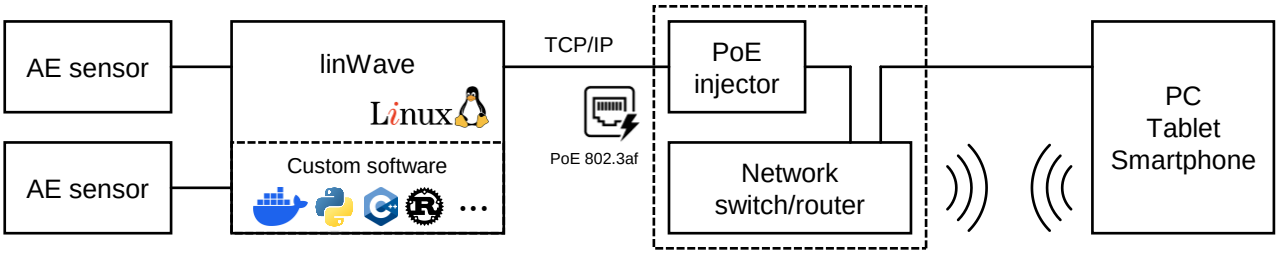

Figure 1: linWave measurement system as block diagram consisting of 2 AE sensors, the linWave device, power supply over LAN and a PC or mobile device running the data acquisition program, data visualization and storing the measurement data.

Operating parameters of the linWave device are set using a PC, laptop, or any other suitable end device, that can connect to the device using the API or Vallen acquisition software.

The linWave device provides data at its TCP/IP socket (IP address and port number). Port 5432 is used to send commands to the linWave device and collect feature data from the Vallen feature extraction unit. Port 5433 and 5434 provide the samples of the raw signal (10 MHz, 16 bit) of channel one and two, respectively. Any software using the Vallen linWave API can retrieve data from these sockets, The Vallen linWave acquisition software connects to port 5432 and receives AE feature data and transient recorder data over it.

The linWave device also supports running a customized feature extraction on its embedded Linux system. This requires a different strategy of controlling and extracting data from the device since the control port 5432 is locked by the customized feature extraction. Data can be provided via MQTT service or pushed to an OPCUA server. Control of the linWave device can be achieved via a REST API.

linWave devices are used when the measurement- or monitoring tasks ask for a distributed device architecture and point location of AE sources in two or three dimensions is not mandatory.

10.1. Intended Use

The linWave device digitizes the AE signal, applies bandpass filters, extracts features from the time stream of data, prepares the transient signal for storing it to an end device and provides a network interface. The intention is to measure signals with amplitudes in the range of a few µV to V and a frequency range of 1 kHz to 1 MHz. As of these characteristics it is suited for measuring Acoustic Emission.

The linWave device can be extended with a custom-built feature extraction, feature analysis and inference engine. The linWave device is delivered in a factory default status with a feature extraction unit that complies to EN 13554 and EN 13477-1.

The linWave device can be operated out-of-the-box as an AE measurement system with the acquisition software provided by Vallen Systeme and the free-to-use VisualAE analysis program. The capabilities of the VisualAE program can be extended with an appropriate software license. The software is compatible to Windows 10 and Windows 11.

A linWave AE device shall only be used by qualified personnel. A definition of qualified personnel can be found in the section Intended Audience.

10.2. Environmental Conditions

Environment	Specification
Site of installation	Indoor and outdoor
Temperature range	0 °C to +50 °C
Relative humidity	Maximum relative humidity of 80% at 31 °C. Linear decrease of relative humidity to 50% with increasing temperature up to 40 °C
Maximum altitude	2000 m
Pollution degree (*)	4 (in mated condition)
Ingress Protection	IP67 (in mated condition)

(*) per IEC 61010-1 and 60664-1.

11. Reasonably Foreseeable Misuse

Use the linWave device only in the specified measurement frequency range. Do not use it with sensors that provide output signals in a frequency range too low (less than 1 kHz) or too high (more than 1 MHz). Especially do not use it with e.g., temperature sensors, strain gauges, displacement sensors or AE sensors with RMS and/or stretched APK output.

Do not install and use a linWave device in an explosion hazardous area.

12. Hardware Types

The linWave device has a type-designation and model number. Both is imprinted on the bottom of the casing.

The linWave device code (product code) is structured in the following way
`<type-designation>_<sampling-rate><channel-number>`:

- `<type-designation>`: the type-designation, i.e.: *linWave*
- `<sampling-rate>`: max. sampling rate in MHz, i.e.: 10
- `<channel-number>`: double-digit channel number, i.e.: 02

Type	Sampling rate in MHz	Channel No.	Model	Code
linWave	10	2	1002	linWave_1002

12.1. Mechanical Properties

Property	Specification
Dimensions	140 mm x 114 mm x 34 mm (W x H x D)
Weight	650 g
Ingress Protection	IP67 No ingress of dust; complete protection against contact (dust-tight) No ingress of water in harmful quantity when immersed in water at a depth of 1 m for 30 minutes
Connectors	2x SMA female 1x Ethernet M12 socket Cat. 6A. 8 poles; X-coded compliant with IEC 61076-2-109
LED	1x 0.6’’ OLED display

13. Front Panel Elements on a linWave Device

Figure 2 shows the front panel elements of a linWave device.

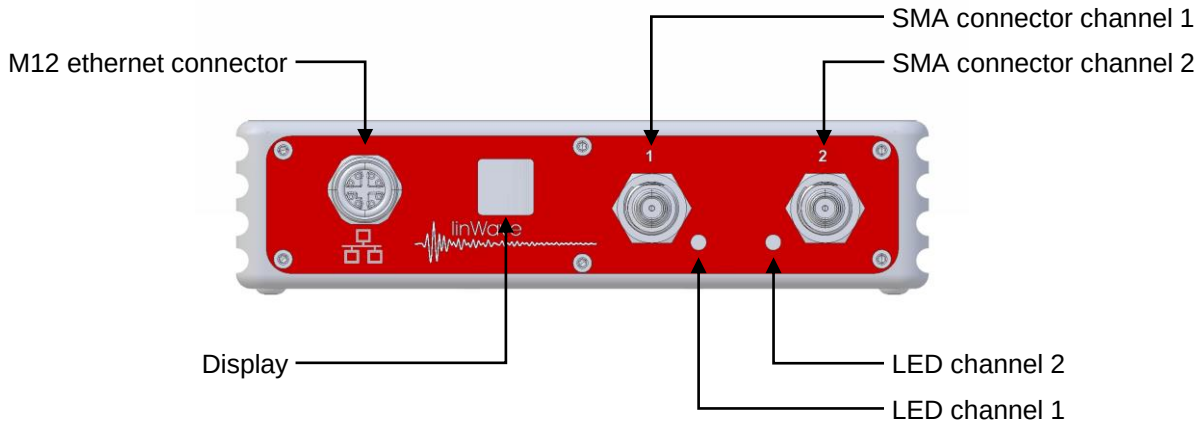

Figure 2: Front panel elements of a linWave device

13.1. M12 Ethernet connector

A linWave device is connected to a local network (LAN) via Ethernet and powered with PoE (“Power over Ethernet”) over the same cable.

Property	Description
Connector type	Ethernet M12 jack Cat.6A 8-pole, X-coded as per IEC 61076-02-109

13.2. Display

Information like the current IP address as well as errors are shown on the display.

Property	Description
Display type	OLED, 0.6’’, 64x64 px

13.3. Sensor connector (in)

The SMA sockets are inputs for AE-signals. Two AE-sensors can be connected to the linWave device.

Property	Description
Connector type	SMA Jack (IP67), female

13.4. LEDs

The LEDs (per channel) indicate the status of each channel.

Property	Description
Cyan	Idle mode
Green	Flashing: threshold exceeded; measurement of a burst signal is started (holding time 30 ms)
Yellow	Flashing: threshold exceeded, measurement of a burst signal started, saturation of ADC occurred (95% of input range exceeded; holding time 30 ms)
Red	Blinking: buffer full in Acquisition mode

14. Mechanical Interfaces

Location	Specification
Rear plate	Two threaded holes, M4x5, 19 mm apart; mechanical interface for a cap rail. Can be used for mounting purposes
Bottom plate	Two threaded holes, M4x5, 45 mm apart; mechanical interface for a cap rail. Can be used for mounting purposes

15. Storing, Transporting and Shipping

A linWave device is delivered in a special card-board box. It shall be used for storage and transportation as it offers protection against shock.

Make sure that the environmental conditions are within specified limits during storage, transportation, or shipping of the device.

When a linWave device is stored or must be shipped, make sure that the acoustic emission sensor input sockets are covered.

16. Installation

Make a visual check of the housing components and connectors before installing a linWave device. Do not continue with installation of a device that is visibly damaged. Contact your service technician or Vallen Systeme GmbH for guidance.

The conditions at the installation site must be within the specified environmental limits. The linWave device is passively cooled and does not require extra airflow nor a guaranteed airflow if it is operated within the limits.

In the case of a long-term or permanent monitoring task the installation site should not be exposed to permanent direct sunlight as this can cause overheating of the device.

16.1. Connecting to Power

The linWave device needs to be connected to a PoE capable switch or router or to a PoE injector. Use the cable that is delivered with the linWave device for connecting it to a network port that supplies PoE.

16.1.1. Power Requirements

Description	Specification
Power supply	Power over Ethernet (PoE), IEEE 802.3af; Device class 3a (max 13 W)
Power consumption	7 W (typically)

16.2. Installing the AE Sensors

For installing the AE sensors follow the instructions in the Acoustic Emission Sensors and Preamplifiers Description or the standard EN 13554, or ASTM E650 or any application standard that can be used for the measurement task.

It is recommended to use AE sensors from Vallen Systeme GmbH.

The cable between an AE sensor and the linWave device should be no longer than 1.5 m if sensors without integrated preamplifier are used. Therefore, the linWave device needs to be installed close to where the sensors are placed.

16.3. Connecting AE Sensors to the linWave Device

Use the cables provided by Vallen Systeme for connecting the AE sensors (without integrated preamplifier) to the input sockets of a linWave device. These cables have a length of 1.2 m. Longer cables can be used if the impact on the signal attenuation is known and has no effect on the safety of the application.

Only use cables that are free of defects and in good shape.

NOTICE

Damaging Electronic Components

Feeding in energy outside the specified range will damage the electronics.

Risk

Feeding in high current will lead to blown fuses and possible damaged electronic components leaving the device inoperable.

How to Avoid the Risk of Damaging Electronic Components

Before connecting cables to SMA input sockets of the device, make sure that the external source is within specified limits.

16.3.1. Connecting AE Sensors with Integrated Preamplifier

The linWave device is intended to be used with AE sensors that have not preamplifier integrated into their housing. This limits the options of where the linWave device can be placed or how far away the AE sensors can be mounted from each other. AE sensors with integrated preamplifiers can be used in cases where the intended sensors cannot meet restrictions of installing a linWave device, e.g., because the distance between linWave device and the position of AE sensors is larger than 1.2 m.

AE sensors with integrated preamplifier need a power supply. The power is supplied to the preamplifier over the same line as the AE signal is transmitted. A so-called decoupling box is needed to decouple the AE signal from the DC power and allow feeding the appropriate power to the preamplifier. The sensors can be placed several hundred meters apart from each other in this scenario. Each sensor needs its own decoupling box. Each decoupling box needs a 24-28 V DC power supply. The decoupling box is installed in close vicinity of the linWave device. The output of which is connected to the signal input of the linWave device. The length of this cable should not exceed 1.2 m.

16.4. Checking the TCP/IP Connection

The linWave device is configured with a static IP address that is shown in the display. Per default the static IP address is 192.254.100.100.

The linWave device receives a dynamic IP address upon boot up if it is connected to a LAN with a DHCP server. The dynamic IP address is displayed next to the static IP address. The linWave device is visible in the LAN if it received a dynamic IP address.

It is recommended to connect the linWave device to LANs with dynamic IP address assignment.

The TCP/IP connection can be checked with a simple PING command. E.g., open the command window and issue the command PING followed by the IP address of the linWave device:

```
C:\Users\tt>ping <IPv4 Address of linWave device> -n 4
```

In the above command example replace `<IPv4 Address of linWave device>` with the dynamically assigned IP address of the linWave device.

The TCP/IP connection to the appropriate port of the linWave device can be checked using PowerShell (Windows 10 or later):

```
C:\Users\tt>powershell
…
PS C:\Users\tt>test-netconnection <IPv4 Address of linWave device> -Port 5432

ComputerName     : <IPv4 Address of linWave device>
RemoteAddress    : <IPv4 Address of linWave device>
RemotePort       : 5432
InterfaceAlias   : Ethernet 3
SourceAddress    : <IPv4 Address of PC>
TcpTestSucceeded : True
```

In the above command-let example replace `<IPv4 Address of linWave device>` with the dynamically assigned IP address of the linWave device. The result of `TcpTestSucceeded` needs to be `True` (see last line).

The linWave device must only be addressed using the static IP address, if it did not receive a dynamic IP address upon power up. A laptop or PC needs to be in the same subnet to set up a working TCP/IP connection. Use the Windows ethernet settings to set an appropriate IP address of the PC (e.g., 192.254.100.101) and subnet mask: 255.255.255.0. Afterwards use the PING command or the PowerShell test-netConnection command-let to verify that the TCP/IP connection is working.

If the Vallen Acquisition software shall be used for acquiring and storing measurement data, install the Vallen AE Suite software and run the linWave acquisition software to confirm that it can connect to the linWave device. For more information see the linWave Operation Manual.

17. Operating a linWave Device

Only operate a linWave device if it has no visible damage and has been properly installed.

For operating a linWave device a working TCP/IP connection is required. Checking the TCP/IP connection is described in the previous chapter.

Only one client can connect to a linWave device.

The linWave device generates AE measurement data. The native Vallen feature extraction unit provides data compliant to EN 13554 consisting of measurements for the peak amplitude, signal energy, burst signal duration, burst signal risetime, ringdown counts, rms of the signal voltage and transient recorder pages. All data is provided at port 5432.

The Vallen Acquisition software and API connects to port 5432. This port is used for controlling the device (e.g., transmit channel settings, start/stop recording) and collecting data from the Vallen feature extraction unit.

Additionally, the linWave device provides a continuous time stream of the signal samples of channels one and two at ports 5433 and 5434, respectively. These ports are not read back by the Vallen Acquisition program. Receiving these time streams requires a customized acquisition software that connects to either or both ports.

Receiving the continuous time streams is only necessary, if a customized feature extraction that goes beyond the one provided by Vallen Systeme is required for an application. A customized feature extraction can run on the client PC that connects to the linWave device. In this case the LAN needs to be able to put through 40 MB/s in a sustainable way.

A customized feature extraction can also be embedded into the linWave device (Linux OS) as can any other application for e.g., analyzing the data. Such applications need to connect to port 5432 to control the linWave device. In this case the port is blocked and cannot be used by the Vallen acquisition program running on a client PC. Data that is generated by such embedded applications can be transmitted via TCP/IP over a separate port or using the OPCUA or MQTT service.

The software license for the linWave acquisition program is part of the linWave device and is perpetual. Data that the linWave device produces can be viewed with the free-to-use VisualAE Lite software. As of this the document focuses on the linWave acquisition software when describing the operation of the linWave device.

The linWave API is described and documented in a separate document: linWave API Specification.

Examples for controlling the linWave device via customized apps and for embedding applications on the linWave device can be found in the Vallen linWave repository at GitHub. Interested parties are requested to pick up contact with a Vallen Systeme Sales team member for more information.

17.1. Measurement Modes

The Vallen feature extraction unit on the linWave device can operate in two modes: (i) identify and separate bursts, called hit-based measurement, or (ii) measure continuously without identifying burst, called continuous measurement. The measurement modes are set by the operator through the linWave acquisition program.

In a hit-based measurement a set of features is measured from a detected burst signal. In a continuous measurement, the time stream of data is divided into time slices. A set of features is measured for each time slice.

17.1.1. Hit Based Measurement

In a hit-based measurement a burst is detected if the signal voltage exceeds a user-defined detection threshold. The end of a burst is identified if the signal stays below the detection threshold for a defined period (Duration Discrimination Time or DDT). A set of features describing a hit are extracted by the Vallen feature extraction unit.

Intensity analysis of recorded data can be done based on the peak amplitude and energy.

Activity analysis can be done based on the number of hits or number of ring-down counts per period.

The arrival time measurement can be used for the AE-source location based on the time difference of arrival. A linWave device supports two AE channels and thus only a two-zone location or a linear location on the line connecting the two sensors is possible. In the case of a linear point location, it means that the actual location of any AE source is projected onto the connecting line.

17.1.2. Continuous Measurement

In a continuous measurement, the time stream of data of a channel is divided into equally long time slices. For each time-slice a set of features is extracted: the peak amplitude, the energy, the time from start of the time-slice to the occurrence of the peak amplitude and the number of crossings of a user-defined voltage limit.

Intensity analysis of the recorded data can be done based on the peak amplitude and energy.

An activity analysis can be done based on the number of crossings of the voltage limit for a certain time slice.

AE source location cannot be done.

17.2. Time Domain Measurement Data

The measurement data is stored to a feature file that meets the SQLite3 standard. The file extension of the feature file is *.pridb. Vallen AE Suite software can read and process this file.

17.2.1. List of Time Domain Features

The Vallen feature extraction unit produces hit data sets and status data sets. The most prominent measured values of a hit data set are the peak amplitude, energy, duration, ring-down counts, and risetime. The name *hit data set* is misleading, since it is also used for describing the set of measured values in a continuous measurement.

A list of time domain features follows in the table below. These features are extracted in a hit based- or continuous measurement. A few conventions apply in a continuous measurement: (i) the duration (D) equals the length of the time slice; (ii) the rise time (R) is the time difference between occurrence of the peak amplitude and the start of the time slice; (iii) the arrival time (TS) represents the start time of the time slice.

Feature	Description
A	Burst signal peak amplitude in units of dB_{AE}. Maximum voltage excursion within the duration of a burst signal
ALIN	Burst signal peak amplitude in units of µV.
D	Burst signal duration Time difference of the last crossing of the detection threshold and the first crossing of the detection threshold
R	Burst signal risetime Time difference between the time of occurrence of the peak amplitude and the time of the first threshold crossing
E	Burst signal energy Integral of the squared acoustic emission signal voltage within the duration of the burst signal
CNTS	Burst signal counts Number of positive threshold crossings in upward direction
RMS	Root mean square of the burst signal
TS	Burst signal arrival time Time of the first threshold crossing of a burst signal
TRAI	Transient recorder index Key of transients in the transient data file used as common key in the primary data file.

Status data sets are generated purely time driven. A status data sets consists of the RMS of the signal voltage and the signal energy accumulating over the time between two status data sets.

Feature	Description
RMSS	Root mean square of the AE signal of a status interval
ENYS	Energy of the AE signal of a status interval

The Vallen acquisition program can also produce label data sets, which are user comments inserted into the time stream of data.

17.3. Transient Recorder

The transient recorder unit generates TR data sets which are stored to a separate transient recorder file that meets the SQLite3 standard. The file extension of the transient recorder file is *.tradb. Vallen AE Suite analysis- and feature extraction software can read and process this file.

A TR data set contains at minimum the sampled signal and the TRAI, transient recorder index, that references the correct hit data set in the *.pridb file.

The transient recorder unit continuously writes the time stream of samples to a random-access memory. The TR data set is generated by extracting the appropriate portion of the stored samples from RAM. The *appropriate* portion consists of the pre-trigger samples, the samples between and including the start trigger to the detected end of the signal, plus the post duration samples. This way of generating a TR data set is called *duration adapted* recording. Upon the start trigger the TRAI is generated and assigned to the TR-data set.

The start trigger is the first threshold crossing in hit-based measurement or the start of the time slice in continuous measurement.

The end is detected when the last threshold crossing is determined in hit-based measurement or with the end of the time slice in continuous measurement.

Pre-trigger samples and post-duration samples are user defined. In the case of a continuous measurement both need to be set to zero if a gapless waveform recording is to be realized. Under these circumstances does the complete TR data consist of pages of constant size. They can be stitched together to produce the complete signal.

TR data sets cannot overlap. Overlap can occur if the time equivalent of the number of pre-trigger samples and post duration samples is larger than the duration discrimination time (DDT). In case an overlap occurs, the trigger to extract a TR data set from RAM is ignored by the transient recorder unit.

18. Product Codes for Ordering

18.1. linWave Device

Product Code	Description
LINWAVE_1002	Dual channel Acoustic Emission measurement device. 10 MHz sample rate, 16 bit, 94/134 dB(AE) input range. Integrated pulser with 30 V. IP67. Power supply via "Power over Ethernet" (PoE). Two SMA connectors for passive AE sensors.

The linWave acquisition software for Windows 10 and 11 is included. The free-to-use VisualAE Lite software can be downloaded at the website of Vallen Systeme.

The product code does not include the ethernet cable, the power supply or any AE sensors and sensor-to-device cables.

18.2. Power Supply

Product Code	Description
POE-INJ_V1	Industrial "Power over Ethernet" (PoE) injector for DIN rail and wall mounting. Gigabit PoE+ (802.3af/at) with up to 72 W. Power supply 24…56 VDC via screw terminal

18.3. Ethernet Cable

Product Code	Description
Cbl-8-*x*M-V66	Ethernet cable for connecting the linWave device to a network port that provides PoE. On linWave side it has an M12 (IP67) connector, on network port side a RJ45 connector. The length can be 2 m, 5 m, 15 m, 20 m, or 50 m and is encoded into the product code instead of the *x* as 2, 5, 15, 20 or 50, respectively.

18.4. Sensor cables

Product Code	Description
CBL-1-1M2-V51	Coax cable for connecting a sensor without preamplifier to the linWave device. The connector on sensor side is SMA format. The length of the cable is 1.2 m. Suitable for operating temperatures up to 100 °C. A 3 m long alternative is available. Product code is CBL-1-3M-V51

Product Code	Description
CBL-1-1M2-V63	Coax cable for connecting a sensor without preamplifier to the linWave device. The connector on sensor side is Microdot format. The length of the cable is 1.2 m. Suitable for operating temperatures up to 100 °C. A 3 m long alternative is available. Product code is CBL-1-3M-V63
CBL-1-1M2-V71	Coax cable for connecting a sensor without preamplifier to the linWave device. The connector on sensor side is SMC format. The length of the cable is 1.2 m. Suitable for operating temperatures up to 100 °C.

18.5. Decoupling Box

Accessories that are required when using AE sensors with an integrated preamplifier.

Product Code	Description
DCPL2	Decoupling circuit in a metal box, to connect a stand-alone Vallen preamplifier with the required DC voltage from an external power supply and to decouple the HF AE signal (e.g. to measure it by an ADC-board) from this DC voltage. Requires 28 V to 30 V DC power.
DCPL-24V-V1	Decoupling circuit in plastic box (polyamide) for 24 VDC power supply and mounting on DIN-rail. The decoupling circuit is needed to connect a stand-alone Vallen preamplifier with the required DC voltage from an external power supply and to decouple the HF AE signal (e.g. to measure it by an ADC-board) from this DC voltage.
PS4DCPL-V1	Switched power supply suited for decoupling boxes. Input range between be 100 VAC to 264 VAC, output 28 VDC, 0.64 A on two banana plugs (4 mm diameter).;

18.6. AE Sensors

It is recommended to use AE sensors from Vallen Systeme. For information about sensors please see separate specification “Acoustic Emission Sensors” (available on www.vallen.de, on the Vallen AE Suite USB drive, or from sales@vallen.de).

19. Maintenance

The input and output sockets can be subject to mechanical and environmental induced deterioration. Do not use the device where a socket is worn out or damaged.

A deteriorated or defective device must be repaired by Vallen Systeme GmbH before it can be used again. Refer to section “What to do in case of malfunction or damage”.

19.1. System Verification

The device’s function can be checked against specifications. A so-called verification of function according to specification is recommended to be done once a year and (i) if a system is suspected to be defective or (ii) if a system has been operated in severe environmental conditions. A verification shall be done in compliance with the standard EN 13477-2. Contact your Vallen Systeme sales agent or Vallen Systeme directly if a verification service is needed.

19.2. What to Do in Case of Malfunction or Damage

Disconnect the device from power. Do not attempt to repair a device. Contact Vallen Systeme and report the defect. Wait for instructions before sending a device back.

20. Compliances Statement

The linWave device complies with following directives:

- Directive 2004/108/EC (EMC)
- Directive 2006/95/EG (LVD)

A linWave AE measurement system complies with following standards:

- EN 13477-1
- EN 13477-2

21. Regulations Concerning Redemption and Disposal

We, Vallen Systeme GmbH, are registered manufacturer of the measurement instruments (WEEE-Reg.-Nr. DE 68150283).

According to German law (§10 subparagraph 2 of Elektro- und Elektronikgerätegesetz – ElektroG) and in the interests of our customers, we accept the obligation for redemption and appropriate disposal of those systems which have been placed by us on the market within the scope of the before mentioned law, after August 13, 2005.

For this we provide the following procedure:

- Owners of old instruments request our agreement with the return of old instruments. The goods to be returned must be described unambiguously and identified by serial number and/or the identification numbers.
- Upon our approval owners may ship the goods free of costs for us.
- We will dispose the goods according to the relevant laws and regulations on our costs.
- Goods returned without our approval will not be accepted and returned to the owner on his account.

With this measure we wish to serve our customers in the best way to properly dispose old instruments and to contribute to re-use, recycling and proper disposal of electronic waste.

Equipment labeled with the symbol shown left must be disposed separately from unsorted municipal waste within the European Union.

22. Restriction of Hazardous Substances (RoHS)

Vallen Systeme GmbH is collaborating with its suppliers to comply with the European Union Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (“RoHS”) Directive (2011/65/EU). The RoHS directive prohibits the sale of electronic equipment containing certain hazardous substances such as lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (“PBB”) and polybrominated diphenylethers (“PBDE”) in the European Union.

23. Worldwide Representatives

ASEAN countries: Singapore, Malaysia, Thailand, Indonesia

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Scandinavian Countries

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```

If you are not within a territory served by a Vallen Systeme GmbH representative, pick up contact with Vallen Systeme GmbH headquarter in Germany, directly.

24. linWave Device Data Sheet

Electrical Properties

Electrical property	Specification
System noise	Input terminated with 50 Ohm: 21.3 dB_{AE} / 2.2 μV_{RMS} within the passband of 95-300 kHz; input range 94 dB_{AE}. Input terminated with 50 Ohm: 44.5 dB_{AE} / 13.8 μV_{RMS} within the passband of 95-300 kHz; input range 134 dB_{AE}.
Input range	94 dB_{AE}, or 134 dB_{AE}; user configurable
Overvoltage protection	±6 V

Signal Processing Properties

Signal processing	Specification
Analogue pass band filter	High pass: 10 kHz 1st order; low pass 1000 kHz 6th order
ADC	10 MHz at 16 bit
Application specific filters	IIR pass band filter, Butterworth characteristic
Filter order	2nd - 8th order (even orders only, user configurable)
High-pass- / low pass frequency	user configurable, 1 kHz to 5 000 kHz

Acquisition mode: continuous / triggered

Acquisition Mode	Description
Hit triggered	The Vallen feature extraction unit initiates burst signal processing if the voltage signal exceeds a user defined threshold. The peak amplitude, energy, duration, risetime, ring down counts and time of first threshold crossing are measured when burst signal processing is active.
Continuous	The Vallen feature extraction unit initiates a measurement in regular intervals. The peak amplitude, energy, risetime and ring down counts are measured. The reference for ring down counts is a user defined voltage limit

Hit Detection and Processing

Hit detection	Specification
Detection threshold	software selectable, fixed during measurement
Hit discrimination	Burst signals are separated if Duration Discrimination Time expires without detection of a threshold crossing
Hit cascade separation	No hit cascading
Hit timeout	automatic termination of a hit if signal's duration > 100 ms. An artificial hit is started automatically after a hit timeout

Hit Feature Extraction Properties

Feature Extraction	Specification	
Arrival time resolution	100 ns	
Arrival time bandwidth	63 bit at a sample rate of 10 MHz (approx. 30 000 years)	
Resolution of amplitude, detection threshold	Input ranges	
	94 dB_{AE}	134 dB_{AE}
	ca. 1.56 µV	Ca. 156 µV
Resolution of rise time and duration	100 ns	
Hit flags	T: hit time out (Duration > 100 ms) A: artificially started hit (after a hit time out),	
Energy resolution	Input ranges	
	94 dB_{AE}	134 dB_{AE}
	243 10^{-21} V^2s	2.43 10^{-15} V^2s
Peak Noise	116 µV at 100 dB_{AE} input range, 1 kHz to 1000 kHz passband, 60 seconds of measurement	

RMS is calculated by the acquisition program based on energy measurement:

$$u_{rms} = \sqrt{E/D}$$

whereby E and D are the energy and duration of (i) a hit or (ii) a status interval. The RMS result can be attributed to a hit or status data set.

Energy conversion factor to Vallen $[eu]$ units is $1\ eu = 10^{-14}\ V^2s$.

Processing Performance

Performance	Specification
maximum processing rate	Continuous mode: > 30 000 time windows per second and channel

Transient Recorder	Specification
Sampling rate	maximum 10 MHz, software selectable decimation factor
Duration adapted recording mode	number of samples that are recorded per trigger depends on duration of the burst signal, pretrigger samples and post duration samples