LAN-XI Data Acquisition Hardware

for PULSE and Test for I-deas

From 2 to 1000+ channels in the same system

LAN-XI Data Acquisition Hardware is a versatile system of modular hardware that can be used as a stand-alone, single-module front-end, as part of a distributed module setup, or collected in 5- or 11-module frames. The hardware works with both PULSE™ and Test for I-deas™.

The individual modules have a very rugged industrial design, perfect for use in the field, and, at the same time, are plug and play modules that you can easily reconfigure in different setups. Running on AC, DC, battery or Power over Ethernet (PoE) and with interchangeable front-panel connectors, LAN-XI hardware provides an extremely flexible system: scalable from 2 to more than 1000 channels with a frequency range of 25.6, 51.2, 102.4 or 204.8 kHz and unlimited data transfer capacity.

120509

Uses and Features

Uses

- Real-time, multichannel sound and vibration data acquisition system: scalable from 2 to 1000+ measurement channels, all phase- and sampling-synchronous (IEEE 1588v2 Precision Time Protocol):
  - Stand-alone, single-module front end for small setups: up to 12 input channels or 4 input/2 output channels
  - Distributed, multichannel system setups with multiple single-module front ends located close to each measurement point
  - Multichannel systems comprising any number of front-end frames in combination with any number of single-module front ends
- Laboratory and field measurements using the same AC, DC, battery or PoE powered system
- Multipurpose conditioning of transducers: same input channel can condition all sound and vibration transducers

Features

- GPS sample synchronization of systems containing a Type 3660-C-100 or 3660-D-100
- Frequency range of 25.6, 51.2, 102.4 or 204.8 kHz depending on module
- Low-frequency auxiliary channels (Type 3056 only)
- High-speed tacho inputs (Type 3056 only)
- Dyn-X® technology input channels, 160 dB input range (except Type 3053)
- Interchangeable front panels (BNC, LEMO or multi-pin connectors) – use your preferred cabling
- Display on each module's front panel:
  - Simplifies system configuration and reduces the time for setting up a measurement system
  - Provides module status information on self-test and error conditions
- Full overload detection including out-of-band overload and generator overload
- Indication of incorrect/defective conditioning on each channel connector
- LAN interface allows the front end to be close to the test object and reduces the number of signal cables and transducer cable length
- Powered by mains, DC, battery or, for stand-alone modules, PoE (IEEE 802.3af)
- Rugged and light modules cast in magnesium
- Silent operation
- Fully compatible with all PULSE applications
- Automatic detection of hardware and transducers:
  - Supports IEEE 1451.4-capable TEDS transducers

LAN-XI data acquisition hardware covers a range of input/output modules that can be used stand-alone, in a distributed network or in frames holding up to 11-modules. LAN-XI hardware is extremely flexible and can be easily reconfigured, as requirements demand, into 2- to more than 1000-channel systems. Applications include:

- Noise source identification using an acoustic array
- Operating deflection shape
- Modal analysis
- Satellite qualification tests
- High-frequency beamforming
- Other high-channel-count measurements in sound and vibration

The modules work equally well as single-module systems, or as part of a large LAN-XI measurement system, making them some of the most flexible data acquisitions modules on the market. In addition, interchangeable front panels give you the flexibility to use a wide range of transducers.

4/6-ch. Input Module LAN-XI 51.2 kHz Type 3050

Type 3050 comes in two basic variants, offering the choice between four and six high-precision input channels with an input range from DC to 51.2 kHz.

The core of the LAN-XI range, these modules are designed to cover as many sound and vibration measurement applications as possible.

3-ch. Input Module LAN-XI 102.4 kHz Type 3052

Specifically designed to measure high-frequency (> 50 kHz) sound and vibration signals, Type 3052 has three input channels with a frequency range from DC to 102.4 kHz. Combined with a dynamic range of 160 dB, this ensures that demanding measurement needs can be met.

12-ch. Input Module LAN-XI 25.6 kHz Type 3053

A 12-channel input module that delivers a compact and cost-efficient solution for high-channel-count applications. Standing alone, Type 3053 is the world's smallest 12-channel sound and vibration analyzer.

4-ch. Input/HS-Tacho + 8-ch. Aux. Module LAN-XI 51.2 kHz Type 3056


120513

This module is aimed at applications where monitoring low-frequency voltage signals along with the sound and vibration signals is required. The module offers a combination of four 51.2 kHz input channels with eight simultaneously sampled, low-frequency auxiliary channels. Unique to Type 3056 is the support of high-speed tacho signals on input channels 1 – 4, which lets you record the signals needed to perform angle domain analysis using PULSE Reflex™ Angle Domain Analysis Type 8740.

Type 3056 features four DC outputs that can be controlled as functions of tolerance-curve and level-meter results. This is used for simple On/Off control of third-party equipment in production test Pass/Fail, etc.

3-ch. Bridge Input Module LAN-XI 102.4 kHz Type 3057


150411

Bridge Input Module Type 3057-B-030 is a three-channel 102.4 kHz LAN-XI module intended primarily for dynamic measurements using PULSE Reflex™, piezoresistive and variable-capacitance accelerometers and pressure sensors. The module also supports strain gauges – full, half and quarter-bridge – as well as strain-gauge-based transducers such as force, pressure and torque sensors. Direct input and CCLD transducers are also supported, including microphones and accelerometers for general sound and vibration measurements.

Type 3057 contains a built-in bridge excitation supply which can be configured either as a 0 – 10 V constant voltage source with optional remote sensing, or as a 0 – 25 mA constant current source.

For further information and specifications see the Product Data for Type 3057-B-030 (BP 2513)

Generator, Input/Output Module LAN-XI 51.2 kHz Type 3160


120514

A combination of inputs and generator outputs make a complete stand-alone analyzer test system. The module is ideal for applications where system excitation is required such as audio and electroacoustic test applications.

Type 3160 comes in two basic variants, offering the choice between 2 inputs/ 2 outputs and 4 inputs/2 outputs. All input and output channels have a frequency range of DC to 51.2 kHz. The combination of input and output channels makes it one of the most versatile data acquisition modules available.

1-ch. Input + 1-ch. Output Module LAN-XI 204.8 kHz Type 3161


130488

Specifically aimed at high-frequency applications such as transducer calibration and underwater defence applications, Type 3161 offers a combination of one input channel and one generator output channel. Both input and output channels have a frequency range of DC to 204.8 kHz. The combination of input connectors – Direct/CCLD, 200 V and Charge – on the front panel allows connection to virtually any microphone and accelerometer, including direct connection to Hydrophone Types 8103, 8104, 8105 and 8106.

Frames and Other Modules

See also:

- LAN-XI Front-end Frame with GPS Types 3660-C-100 (5-module) and 3660-D-100 (11-module) on page 15
- 1-module Wireless LAN Frame Type 3660-A-20x on page 16
- Notar™ BZ-7848-A (LAN-XI stand-alone recorder license) on page 17
- Battery Module Type 2831-A on page 14

Table 1 *LAN-XI front-end modules*

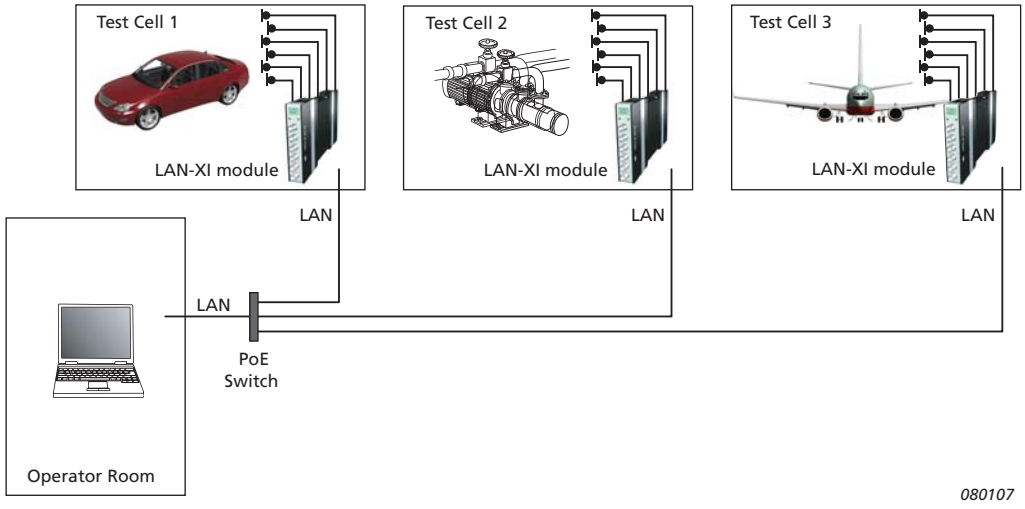
Input Type*	Product Name	Type Number	Input Channels	Generator Output Channels	Frequency Range	Front-panel Connectors Included
Direct, CCLD†, Mic. Preamp. (0 or 200 V Polarization Voltage) Charge‡	6-ch. Input Module LAN-XI 51.2 kHz (Mic, CCLD, V)	3050-A-060	6	–	0 to 51.2 kHz	BNC: UA-2100-060
	4-ch. Input Module LAN-XI 51.2 kHz (Mic, CCLD, V)	3050-A-040	4	–		BNC: UA-2100-040
	4-ch. Input Module/HS Tacho + 8 ch. LAN-XI 51.2 kHz (Mic, CCLD, V, HS Tacho, Aux)	3056-A-040	4 + 8	–		BNC: UA-2111-040
	Generator, 4/2-ch. Input/Output Module LAN-XI 51.2 kHz (Mic, CCLD, V)	3160-A-042	4	2		BNC: UA-3100-042
	Generator, 2/2-ch. Input/Output Module LAN-XI 51.2 kHz (Mic, CCLD, V)	3160-A-022	2	2		BNC: UA-2100-022
	3-ch. Input Module LAN-XI 102.4 kHz (Mic, CCLD, V)	3052-A-030	3	–	0 to 102.4 kHz	BNC: UA-2100-030
	1-ch. Input + 1-ch. Output Module LAN-XI 204.8 kHz (Mic, CCLD, V)	3161-A-011	1	1	0 to 204.8 kHz	BNC/LEMO/TNC: UA-2117-011
Direct, CCLD†, Charge‡	12-ch. Input Module LAN-XI 25.6 kHz (CCLD, V)	3053-B-120	12	–	0 to 25.6 kHz	SMB: UA-2107-120
Bridge, Direct, CCLD†	3-ch. Bridge Input Module LAN-XI 102.4 kHz	3057-B-030	3	–	0 to 102.4 kHz	Sub-D: UA-2121-030
Battery Module						
–	Battery Module	2831-A	–	–	–	UA-2106

* Supply for older MM-0012 and MM-0024 photoelectric tachometers not available. Compatible with CCLD Laser Tacho Probe Type 2981. RS−232 connector for remote control not available
† Constant Current Line Drive
‡ Via CCLD Converter Type 2646 or the range of Charge to CCLD Converters Type 2647

System Configuration

The ability to use any module as stand-alone, in a frame or in a distributed system means that you can place your modules close to the measurement object, and the Precision Time Protocol (PTP) makes it possible to synchronize the clocks in the system components with sub-microsecond accuracy. With PoE, all you need between the modules and the PC are shielded CAT6 LAN cables and a PoE switch. This minimizes the number of cables required and results in lower cost, less downtime, easier maintenance, greater flexibility and greater installation speed.

Fig. 1
Using LAN-XI, cabling between test cells and operator room is drastically reduced to only a few LAN cables



With GPS synchronization, available with Types 3660-C-100 and 3660-D-100, it is possible to synchronize the clocks of systems so that otherwise independent systems acquire sample-synchronous data.

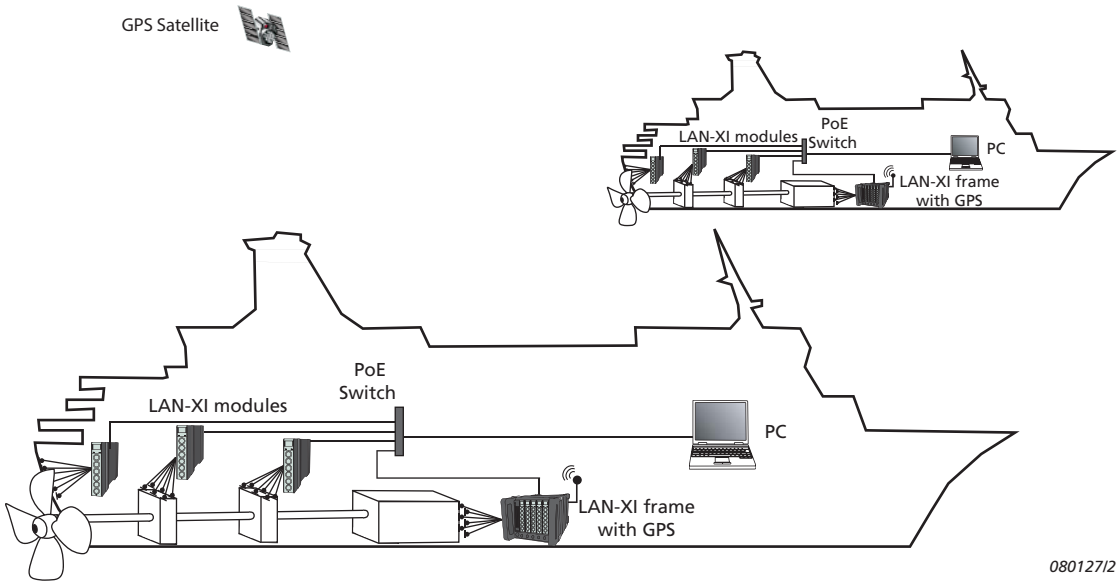


Fig. 2
With a distributed system where modules are situated close to the measurement object, transducer cabling is also drastically reduced for measurements on large structures. With GPS synchronization added, data acquisition can be synchronized over large distances

Building a Configuration

Configurations of one or more LAN-XI modules and frames are easily managed using a front-end browser via the PULSE Front-end Setup program. You can select modules and frames, access the modules' home pages, change IP addresses, flash the modules' LEDs, update firmware, etc.

IP Addresses

Each module has its own built-in network interface. This can be configured to use dynamic or static IP addressing, via the module's display or its home page:

- If the modules are set up to use dynamic IP addresses (default), the modules automatically receive their IP addresses from a DHCP server on the network. If this is not found, as in the case where a module is connected directly to a PC, the module will use "link-local" ("auto-IP"). This means that an address in the 169.254.xxx.xxx range is selected. A PC with Windows® 7 or 8.1 operating system will by default do the same, which means that the two can communicate
- If static addresses are selected, they can be changed later by using the front-end browser

Technologies

Sample Synchronization Technique: Precision Time Protocol

For most sound and vibration applications, sample-synchronous and phase-matched measurements are a must. If no synchronization method is used, two or more sampling systems will drift apart over time. Even the best clock systems available will, in less than 10 seconds, drift so far apart that the sample correlation will drop to an unacceptable level for high-quality sound and vibration measurements. Traditional measurement systems have a common sample clock ensuring synchronization between measurement channels located in the same front-end frame. Newer systems have offered various cable-based synchronization techniques between different front-ends – all with the significant disadvantage of requiring extra cabling.

With LAN-XI, Brüel & Kjær uses a powerful technique to ensure sample-synchronous measurements over the same LAN connection used for transferring the measurement data. This simplifies the measurement system's cabling and makes it possible to perform sample-synchronous measurements over long distances, eliminating the effect of delays over the cable and interconnected switches. PTP synchronization provides a whole new set of possibilities for combining measurement systems located different places: closer to the actual measurement point, in different rooms/test cells, with long distances between equipment. The only thing that is required is a LAN connection.

In practice:

- Less cabling is required so less time used for setting up a measurement system
- Less cable infrastructure is needed when defining and setting up new test cell facilities
- Much easier reconfiguration of existing test setups
- Highly accurate measurements are possible over long distances with only a LAN connection

The IEEE 1588 Precision Time Protocol

PTP synchronization measures the delays between individual PTP components using a special algorithm (see the IEEE 1588 standard*). By doing this, all delays can be accurately measured, and the individual clocks can be set to exactly the same time. On top of this, the phase drift of the "slave" clocks is continuously measured and counter-adjusted by a control loop, which adjusts the slave clocks' speed. All Brüel & Kjær sound and vibration applications will work with most† high-performance 1-gigabit switches, but have superior phase characteristics with a dedicated PTP switch such as 10-port Gigabit Managed Switch with PTP and PoE (8 ports) UL-0265.

GPS Sample Synchronization

GPS sample synchronization is available with LAN-XI Front-end Frame Types 3660-C-100 and 3660-D-100.

Traditional data acquisition configuration requires a cabled synchronization mechanism to acquire sample-synchronous data on all front-ends and modules, a prerequisite of many sound and vibrations applications needing cross-spectral analysis between channels.

Applications such as automotive pass-by, fly-by or structural tests on large or moving constructions such as buildings, bridges or wind turbines, make it very cumbersome, and often impossible, to deploy a synchronization cable. Use of WiFi is not optimal due to fallout and quite often not possible.

The support of GPS synchronization allows the use of the time provided by GPS Satellite as the unique reference, making synchronization cables obsolete. This allows the use of distributed data acquisition configurations where each individual system acquires sample-synchronous data with any of the other systems.

GPS time is used:

- To define the absolute time that follows the acquired data
  - Traditionally, the absolute time is set by the PC in control of the acquisition and the accuracy is as good as the PC clock, typically 1 second
- As an accurate time-base that locks the PTP clock on both the LAN-XI Master Frame and any slaves
  - Continuous tracking with GPS time allows the acquisition of very long time signals with very high time precision

GPS synchronization can be used in a standard PULSE system with PTP among modules and frames, but with GPS in the PTP master, the clock is now absolute and very accurate. You can also have several, completely detached, PULSE systems that each record their data with an absolute GPS time stamp and with data samples locked to the GPS clock.

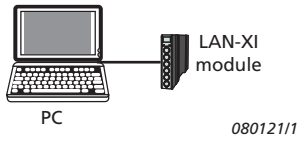
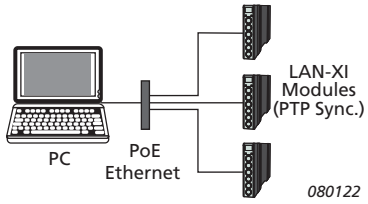
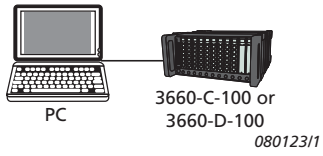
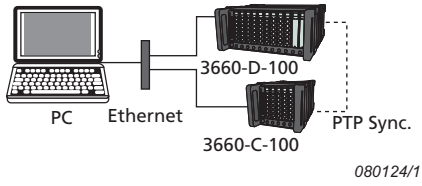
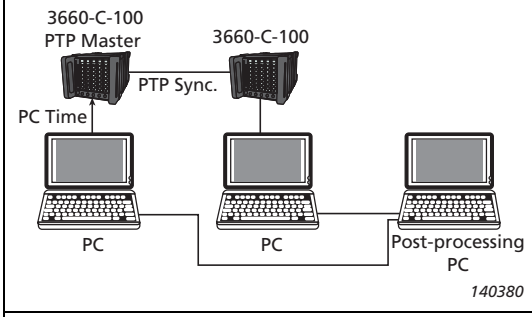
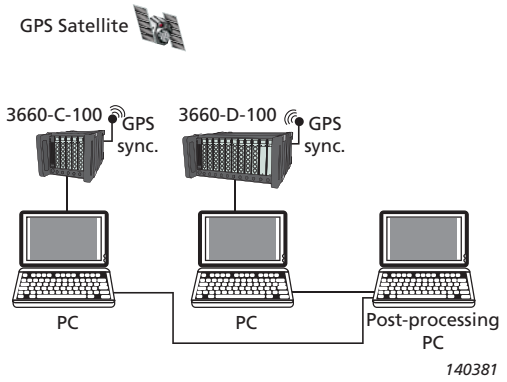
Power over Ethernet

PoE is implemented according to IEEE 802.3af. PoE is wired Ethernet LAN technology that, with a suitable PoE LAN switch, allows the power needed for each module to be carried by screened shielded twisted pair (S/STP or S/FTP) CAT6 LAN cables rather than by separate power cables. This minimizes the number of cables required and results in lower cost, less downtime, easier maintenance and greater installation flexibility. PoE switches, such as 10-port Gigabit Managed Switch with PTP and PoE (8 ports) UL-0265, and PoE injectors, such as ZyXEL® PoE-12 Power over Ethernet (a single-port PoE injector), can be used.

* IEC 61588/IEEE 1588-2008, Precision Clock Synchronization Protocol for Networked Measurement and Control Systems.

† The switch must treat IEEE 1588 packages with same priority as data traffic. Some "non-PTP-aware" switches do not.

Table 2 *Examples of different system setups, from single-module to multi-frame systems with GPS sample synchronization.*
Note: *Any LAN switch can be used*

	**Single-Module System** • Select the preferred type and module variant (see Table 1 for details) • Add an optional front panel as required (see Table 1) • Add Battery Module Type 2831-A as required (includes external mains chargers, in-vehicle charger optional)
	**Distributed System** • Select any number of types and variants (see Table 1 for details) • For operation using PoE, add a PoE switch and appropriate LAN cabling • Add optional front panels as required (see Table 1) • Add Battery Module Type 2831-A as required (includes external mains chargers, in-vehicle charger optional)
	**Single LAN-XI Front-end System** • Select 5-module LAN-XI Front-end Frame Type 3660-C-100 or 11-module LAN-XI Front-end Frame Type 3660-D-100 • Add up to 5 or 11 modules (see Table 1 for details) • Add Battery Module Type 2831-A as required (up to two) • Add optional front panels as required (see Table 1)
	**Multiple LAN-XI Front-end System** • Select the required number of LAN-XI Front-end Frames Type 3660-C-100 or 3660-D-100 • For each frame, add modules as required (see Table 1 for details) • Add Battery Modules Type 2831-A as required (up to two in each frame) • Add optional front panels as required (see Table 1)
	**Multiple PTP System** • Select the required number of LAN-XI Front-end Frames Type 3660-C-100 or 3660-D-100 • For each frame, add modules as required (see Table 1 for details) • Add Battery Modules Type 2831-A as required (up to two in each frame) • Add optional front panels as required (see Table 1)
	**GPS Multiple LAN-XI Front-end System** • Select the required number of LAN-XI Front-end Frames Type 3660-C-100 or 3660-D-100 • For each frame, add modules as required (see Table 1 for details) • Add Battery Modules Type 2831-A as required (up to two in each frame) • Add optional front panels as required (see Table 1)

Dyn-X Technology – Single Range from 0 to 160 dB

Dyn-X is an innovative range of state-of-the-art input modules with a single input range from 0 to 10 V_p and a useful analysis range exceeding 160 dB.

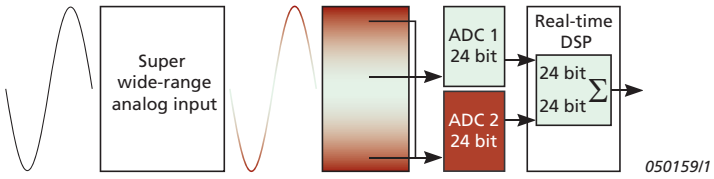


Fig. 3
Simplified block diagram of Dyn-X principle

To date, high-quality transducers and preamplifiers have outperformed measuring equipment with regard to linearity and dynamic performance, being able to deliver a noise- and distortion-free signal over a dynamic signal range of 120 to 130 dB broadband and 160 dB narrow-band.

With Dyn-X technology, the entire measurement and analysis chain, for the first time, matches or outperforms the transducer used for measurement. This eliminates the need for an input attenuator for ranging the analysis-system input to the transducer output. All you need to do to get excellent results is choose the right transducer.

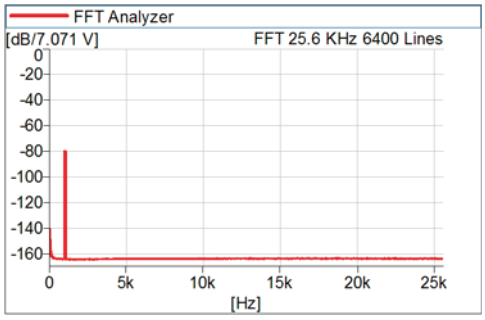


Fig. 4
160 dB analysis in one range. An FFT measuring a 1 kHz signal 80 dB below full scale (7 V_{rms}). Note that noise and all spurious components measure 160 dB below full-scale input

Transducer Overload

Transducer maximum output level can be entered in the PULSE Transducer Database. If the input exceeds the maximum level, Dyn-X modules will give an overload warning on the front-end (and in the PULSE Level Meter).

Accuracy, Safety and Efficiency

Covering everything in one input range, you no longer have to worry about overloads, underranged measurements or discussions about the validation and verification of measurement results. With no need for trial runs in order to ensure that the input range is correct, you have a far greater certainty of getting measurements right first time.

The measurement situations and applications below are examples of where Dyn-X technology can be usefully employed:

When you need to get the measurement right first time	• Crash testing • Destructive testing • Heavy machinery – run up/coast down
Where there is minimal user interaction	• Road testing • Field testing
When time is limited	• Test cells • Wind tunnels • Road testing • Flight testing
When testing is unattended	• Production line • Noise monitoring

When signal levels are unknown	• Run up/down • Field testing
When an overview of the whole measurement scenario is difficult	• When measuring many channels • When combining more signal types: vibration, sound, temperature, pressure, RPM, etc. • Test cells • In-car testing • Sound, vibration and other parameters involved
High-dynamic applications	• Impulsive testing, room acoustics • Run up/down • Electroacoustics • Structural measurements

Assistance and Feedback

All LAN-XI input/output modules provide assistance in setting up your system and monitoring its status. Combined with the use of the Level Meter in PULSE LabShop or PULSE Reflex™, you can easily see whether your system is working as intended and, if not, where any attention is needed for correcting transducer mounting or cabling.

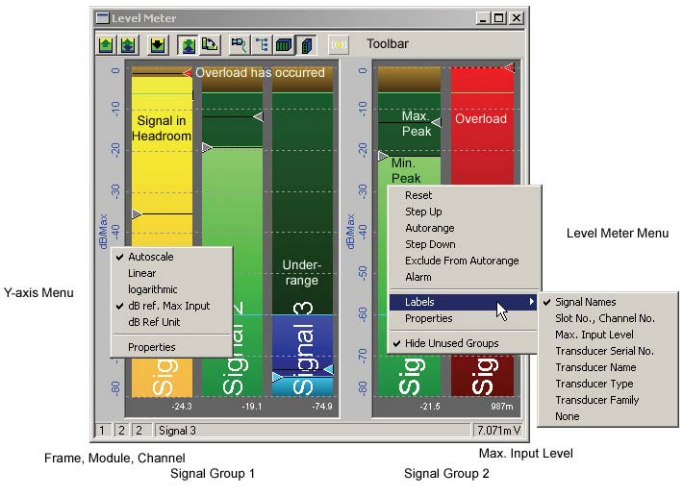
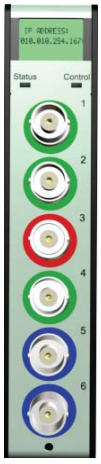


Fig. 5
The level meter in PULSE LabShop

Each module has a display and each channel has an LED to help you locate a specific module or channel and determine whether the system is functional and configured correctly and the transducers in good working order. You can toggle the display between module ID, IP address, PTP status and any error indications, including self-test and overload. The display automatically changes if an error arises. In addition, each module has its own home page containing information about the module, including frame configuration, calibration history, self-test, and log file. The home page can be accessed directly from an Internet browser without the need for a PULSE license.



The LEDs on each connector display status colours to indicate the following conditions:

- Green – active input channel
- Red – input overload; cable, transducer or conditioning fault
- Purple – input overload during recording session with LAN-XI Notar stand-alone recorder
- Yellow – transferring TEDS data
- Blue – generator output
- Blue/Red (alternating at 0.5 s) – error on generator output, overload or cable short-circuit

The clear indication of the selected channel, combined with the use of IEEE 1451.4-capable transducers with standardized TEDS, greatly simplifies system setup.

All LAN-XI Modules

Features

- Multipurpose transducer support (see Input Channels)
- Designed for field use: rugged and light, cast in magnesium
- Interchangeable family of front panels – direct connections to transducers without patch panels or adaptor cables
- Front-panel display of ID/IP address/ status/error conditions
- Silent operation (no fan)
- Single LAN cable operation for data transfer, power supply (PoE) and synchronization (PTP) in distributed measurement systems
- Mains Power Adaptor ZG-0426 included with each module

Power Supply

Each module can be powered by:

- Mains adaptor, 90 – 264 V AC, 47 – 63 Hz
- Battery Module Type 2831-A
- 10 – 32 V DC
- PoE according to IEEE 802.3af

Each module can be used, for example, in the field with a DC supply or as part of a distributed measurement system using PoE. Use in a distributed system minimizes the requirements for transducer cables – all you need between the modules and the PC are LAN cables and an Ethernet switch. In addition, modules can be easily plugged into the Type 3660-D-100 frame (described below), or two or more modules can be attached to each other using integrated screws*.

Silent Operation

Operation is silent in a LAN-XI frame as long as the temperature of the unit is within safety limits. If the maximum safe operating temperature is reached, cooling fans activate.

Interchangeable Front Panels

The modules allow front panels to be interchanged freely, with a variety of connectors for different transducers and applications. See Input Channels for a list of supported transducers.

This results in fewer patch panels, less cable "spaghetti", fewer cable adaptors and faster system setup. Most connector panels can be used on any module. If an illegal combination is used, the module will stop during power-up and display an error message.

The front panels available for use with LAN-XI modules are described in a separate Product Data (BP 2421) with details of compatibility with the different LAN-XI modules.

Input Channels (all modules)

Uses

- Input channels for multichannel sound and vibration measurements

Features

- Dyn-X on all input channels (except Type 3053)
- Frequency range†:
  - Types 3050, 3056 and 3160: 0 to 51.2 kHz
  - Type 3052: 0 to 102.4 kHz
  - Type 3053: 0 to 25.6 kHz
  - Type 3161: 0 to 204.8 kHz
- Input voltage up to 10 V_{peak} and extended range up to 31.6 V_{peak}
- Absolute maximum input 60 V_{peak} without damage
- Support IEEE 1451.4 capable transducers with TEDS
- Automatic DC offset compensation
- Extremely low noise floor
- Selectable floating or grounded inputs
- Low out-of-band spurious noise
- Overload indicator indicates overload, incorrect conditioning and cable breaks on connected transducers
- Overload detection including out-of-band frequencies

* Connecting two or more modules will reduce maximum ambient operating temperature. There is no reduction in ambient temperature limit when using a single module with a Type 2831-A battery

† Measurement frequency range can be selected in software

- Tachometers: self-powered, externally powered and CCLD powered including Type 2981 (power supply for legacy MM-0012 and MM-0024 not available)

These multipurpose input channels can be used in combination with the modules' interchangeable front panels to connect and condition all relevant sound and vibration transducers including:

- Microphone preamplifier with prepolarized microphone
- Microphone preamplifier with 200 V microphone polarization voltage (A-variants only)
- CCLD microphones
- Proximity probes
- Accelerometers
- CCLD accelerometers
- DC accelerometers (differential bridge input)
- Charge transducers (via CCLD converter)
- AC/DC
- High-speed tacho signals from angle encoders (Type 3056 only)

Independent Channels

The input channels on a module can be set up independently. You can set up the high-pass filters and input gain separately and attach different types of transducers to different channels. The microphone polarization voltage can be switched on or off for each channel.

IEEE 1451.4 Transducers

All input modules support TEDS transducers. This allows automatic front-end and analyzer setup based on TEDS information stored in the transducer, for example, sensitivity, serial number, manufacturer and calibration date. The individual frequency response of a transducer can be corrected for using PULSE's transducer response equalization, REq-X, to achieve higher accuracy over extended frequency ranges.

Overload

The input modules use two methods to detect transducer cable breaks and incorrect conditioning. For microphones, their supply current is monitored; for CCLD accelerometers (or microphones using CCLD preamplifiers), the supply voltage is monitored. If conditioning errors, such as a broken cable, are detected, an error is indicated as an overload on the specific channel.

Overload indications for input channels include (see Specifications for details):

- Signal overload with adjustable detection level
- CCLD overload: detection of cable break, short-circuit or CCLD transducer working point fault
- Microphone preamplifier overload: detection of microphone preamplifier current consumption too high or too low
- Common mode voltage overload: relevant when input coupling is floating

Ground-loop Noise Suppression

The module's floating/grounded, differential input design and the fact that all external connections (LAN, power supply) are galvanically isolated in the module provide optimal ground-loop noise suppression.

Protection

If the signal input level to a module significantly exceeds the measuring range, the input will go into protection mode for at least 0.5 s until the signal falls again. While protected, the input is partly switched off and the input impedance is greatly increased. (The measured value will be strongly attenuated but still detectable.)

High-speed Tacho (Type 3056 only)

Of the four input channels on Type 3056, channels 1 and 3 can be independently configured to support high-speed tacho signals needed to perform high-precision angle domain analysis on fast-rotating machinery and combustion engines. Channels 2 and 4 can be independently configured for tacho reference signals. The high-speed tacho signals are typically supplied from angle encoders.

Note that PULSE Time Data Recorder Type 7708 supports only two high-speed tacho channels (one tacho channel and one tacho [angle] reference channel). For full support of four high-speed tacho channels, use PULSE LabShop.

	PULSE LabShop	PULSE Time Data Recorder Type 7708
Ch. 1	High-speed tacho signal or normal input	High-speed tacho signal or normal input
Ch. 2	High-speed tacho ref or normal input	High-speed tacho ref or normal input
Ch. 3	High-speed tacho signal or normal input	Normal input
Ch. 4	High-speed tacho ref or normal input	Normal input

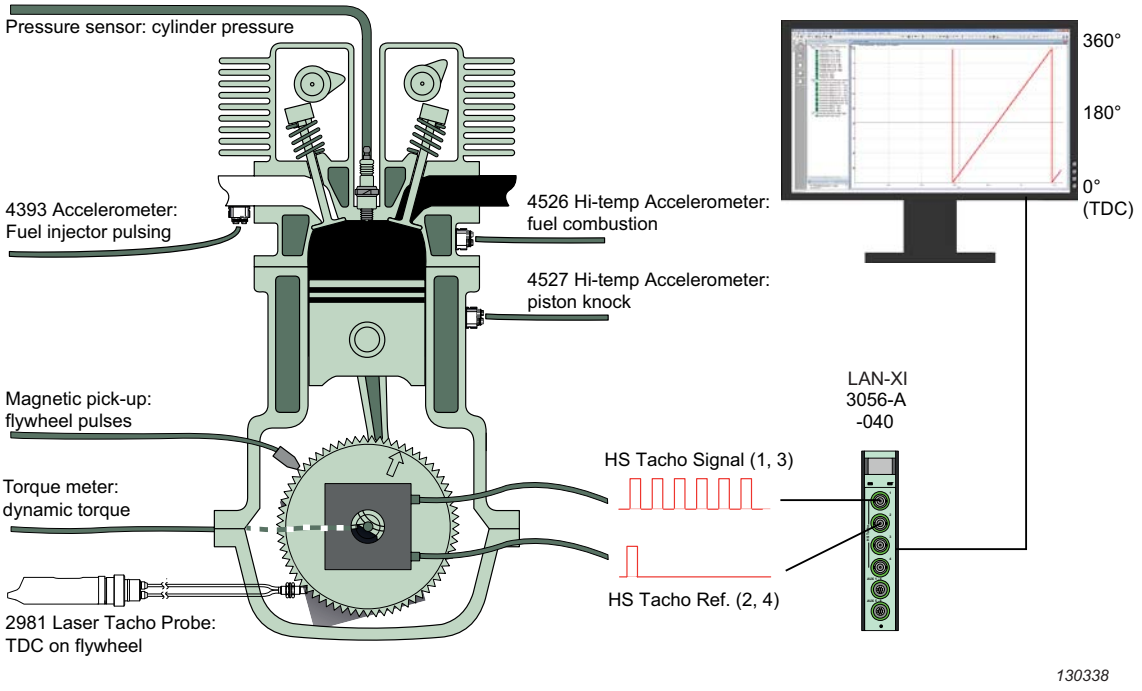


Fig. 6
PULSE Reflex Angle Domain Analysis Type 8740 (BP 2433) uses angle profile and key phasor information from high-speed tachometer and tachometer reference signals for angle calculation and subsequent cycle extraction for applications such as crank angle analysis.

Auxiliary Channels (Type 3056 only)

Auxiliary channels can be used for measurement of auxiliary, pseudo-DC parameters with up to eight low-frequency (16 Hz sample rate) input channels that can be recorded along with the dynamic channels and used as logging or multi-buffer tags. Auxiliary channel settings and data are accessed via OLE2 automation interface.

Typical applications include:

- Automotive: intake pressure, thermocouples, throttle position, vehicle acceleration/braking
- Industrial: process parameters (temperature, pressure, control position, etc.)
- Production Line Testing: PLC control parameters, environmental conditions (temperature, barometric pressure)
- Pass-by Testing: environmental parameters
- Auxiliary data like temperature and wind speed available as time data or as z-axis tags
- Integration of auxiliary parameters with dynamic data such as FFT, Order and CPB spectra

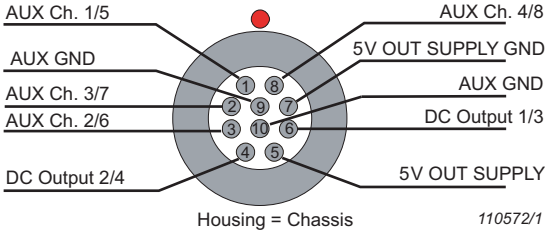


Fig. 7
10-pin LEMO auxiliary connector

The eight auxiliary input channels are present on two 10-pole connectors, each of which is sampled 16 times per second. The channels are single-ended and have a single 10 V input range.

Fig. 8 *Break-out Box ZH-0699*

130369

Fig. 9 *Auxiliary cable AO-0738-D-010*

110717/1

Break-out Box ZH-0699 (Fig. 8), with 2 × 10-pin LEMO* (M) connectors, is available as an accessory and provides BNC connectors for the eight auxiliary signals and four DC outputs.

Auxiliary cable AO-0738-D-010, 2 × 10-pin LEMO* (M) to 8 × BNC (F) plus ground (Fig. 9), is available as an accessory (inputs only). DC outputs require a custom cable or Break-out Box ZH-0699.

Output Channels (Type 3160 and 3161 only)

Uses

- Generator output channels for system excitation for sound and vibration measurements

Features

- Type 3160: Two independent output channels – full generator functionality from 0 to 51.2 kHz
- Type 3161: One output channel – full generator functionality from 0 to 204.8 kHz
- Output voltage up to 10 V_{peak} and output current up to 40 mA_{peak}
- Waveforms determined by software (see below)
- High amplitude and frequency linearity
- Extremely low noise floor
- Selectable floating or grounded outputs
- Capable of heavy complex loading without instability
- Low out-of-band spurious noise
- Overload detection on individual channel(s) – voltage and current – indicated by alternating red/blue LEDs on the front panel
- Generator channel(s) indicated by blue LED on the front panel
- Automatic shutdown (muting) of output channel(s) at power failure
- Full output phase control among LAN-XI modules

The output channels can be used as high-quality signal generators with a frequency range from 0 to 51.2 kHz (Type 3160) or 204.8 kHz (Type 3161) and can supply the signals necessary for performing system analysis.

The modules are designed around a powerful digital signal processor and a low-noise, 24-bit, D/A converter and have exceptional flexibility, stability and accuracy. Output levels are adjustable from 10 μV_{peak} to 10 V_{peak}. The output signal is provided by a BNC connector and can be referred to ground or floating. It is possible to add a DC offset, but any unwanted DC offset is automatically removed.

* LEMO FGG.1B.310.CLAZ31.

Waveforms

The waveform types supported by PULSE are:

- Single fixed sine (continuous or burst)
- Single swept sine
- Dual fixed sine
- Dual swept sine (Type 3160 only)
- Fixed sine plus swept sine
- Stepped sine (with Steady State Response Analyzer)
- Random (continuous or burst)
- Pseudo-random
- Periodic random
- User-defined, arbitrary waveforms can be streamed/ downloaded

Overload

Output voltages above 11 V_{peak} or output currents above 40 mA_{peak} are indicated as overloads by the circular LEDs on the output channels.

Security

Output is automatically shut down in cases of heavy overload (shorted output) that could affect module functionality by drawing more current than available. The signal ramps up again when the overload is removed.

Monitor Output (Type 3161 only)

An output signal is available on a BNC connector that allows you to monitor the input. The signal is taken after the high-pass filter but before the anti-aliasing filter. The signal is always referred to (chassis) ground. The specifications for this output are the same as the input channel. In the 31.6 V range, the signal is attenuated by 10 dB (3.16×). **Note:** Charge signal is inverted.

DC Output (Type 3056 only)

The four programmable DC outputs of Type 3056 (Fig. 7) are open-drain outputs that are able to sink 100 mA from an external supply of up to 24 V, sufficient for a relay. DC output without an external supply is 5 V, max. 50 mA. DC outputs require a custom cable.

Battery Module Type 2831-A

The battery module is a rechargeable Li-Ion battery with an output voltage of 14.8 V and a capacity of 6400 mAh. This provides over seven hours of operation with a single LAN-XI module or over 40 minutes in a LAN-XI Frame Type 3660-D-100. Two Type 2831-A batteries can be used simultaneously in a Type 3660-D-100 to provide over 80 minutes of continuous battery power for a full frame.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Type 2831-A also acts as an uninterruptable power supply (UPS) for a frame or single module when connected to it by the included ZH-0686 single-module-to-battery power adaptor. This allows the battery to seamlessly power the module or frame if external power is temporarily lost (for example, in a car when the ignition switch is turned).

On the front panel, five LED status indicators show the remaining capacity. When a battery is used in a LAN-XI frame, charging status and remaining capacity can be checked via software.

The battery module can be charged in a LAN-XI frame (when mains powered) or with a dedicated external charger. Type 2831-A includes a mains powered external charger, ZG-0469. An optional DC external charger (for example, in-vehicle charger) is also available as ZG-0858.

The battery module is the same size as a standard LAN-XI input/output module.

Features

- Type 3660-C-100 houses up to 5 input/output modules (up to 60 channels)
- Type 3660-D-100 houses up to 11 input/output modules (up to 132 channels)
- GPS connector for defining the absolute time and providing an accurate time base for synchronized data acquisition within a system or between systems in different locations
- Robust casing for industrial and hard everyday use
- Mains (90 – 264 V AC, 47 – 63 Hz), DC powered (11 – 32 V) or battery (optional)
- Silent operation (cooling fans turn on only at maximum safe temperature)
- Phase- and sample-synchronous measurement with other LAN-XI front ends
- Plug and play modules can be removed for field measurements using a single module or swapped for calibration or repair
- Modules can be locked or screwed in place

LAN-XI Front-end Frames with GPS Type 3660-C-100 and 3660-D-100 are data acquisition systems comprising a frame that contains modules that can be freely chosen from the available I/O modules (see Table 1). With a 1-gigabit LAN backbone, each frame provides full throughput of all channels. With GPS synchronization, synchronization cables are no longer required and measurements can be made at widely spaced locations. The GPS time stamp ensures that the measurements are sample synchronized, enabling cross-spectral analysis between channels.

Types 3660-C-100 and 3660-D-100 replace the earlier LAN-XI Front-end Frames Type 3660-C and 3660-D.

Power Supply

Types 3660-C-100 and 3660-D-100 both have an integral transformer for connecting a 90 – 264 V AC, 47 – 63 Hz mains power supply or can be powered from an 11 – 32 V DC supply. In addition, each frame can house up to two Battery Modules Type 2831-A, which are capable of powering nine input/output modules for up to 40 minutes. Batteries can be hot-swapped to extend operation time. Frames cannot be powered by PoE.

DC Output and Additional PoE Ethernet Port

Types 3660-C-100 and 3660-D-100 have a 12 V DC, 1 A output (EIAJ-05 connector) with current protection to provide power for accessories such as a LAN switch for interconnecting more front ends or wireless LAN for remote control. Cables for these accessories must be purchased separately.

The frames also include a second PoE port for power and to connect to wireless access points (WAP) and cameras that support PoE.

Silent Operation, Cooling

Operation is silent as long as the temperature of the unit is within safety limits. If the maximum safe operating temperature is reached, cooling fans activate.

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Uses

- Front end for Sonoscout™ NVH Recorder BZ-595
- In-vehicle NVH recordings
- Wireless PULSE front end
- For applications where LAN cables are not practical
- Remote controlled LAN-XI Notar stand-alone recorder

Features

- Connects a LAN-XI Battery Module Type 2831-A and a single LAN-XI input module
- Functions as the access point for wireless networking
- Wireless recording and measurement of up to twelve channels
- Only one wireless LAN network is connected to the LAN-XI module at a time

Benefits

- Truly wireless front end
- Compact
- Allows optimal positioning of front end and user interface
- Minimum cable clutter

Fitted with LAN-XI Battery Module Type 2831-A, Wireless LAN Frame Type 3660-A-200 allows you to connect any existing LAN-XI module wirelessly to your PULSE or Sonoscout system. This gives you the freedom to move your hardware around, without the need for cables.

The Wireless LAN Frame status information is available on the front end's home page.

Fig. 10
Configuration A

130148

In the 'A' configuration (Fig. 10), Type 3660-A-20x can be used as a wireless PULSE front end for PULSE LabShop, PULSE Reflex and PULSE Time Data Recorder.

Fig. 11
Configuration B

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In the 'B' configuration (Fig. 11), it is an integral part of Sonoscout System Type 3663.

Once connected, the battery module provides power for the front-end combination. If powered from DC input, the battery acts as a UPS for several hours.

A captive screw and hex wrench are provided under the easily removable cover to secure the unit to the front-end combination.

Fig. 12
View showing connectors of Type 3660-A-20x

To access the micro-SD card in your LAN-XI module you need to remove Type 3660-A-200, Fig. 12.

Note:
This Wireless LAN Frame is also available in a Japanese version, Type 3660-A-201, and a US version, Type 3660-A-202. See the separate Product Data for the Japanese version (BP 2487).

Notar™ BZ-7848-A (LAN-XI stand-alone recorder license)

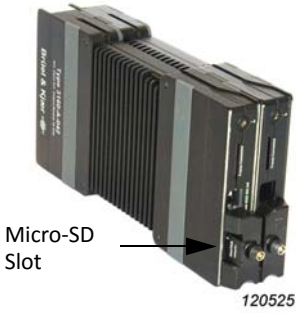
Uses

- Record time data to SDHC memory card (wav files): no need for PC
- Remotely access the recorder over wired LAN (standard) or wireless LAN or 3G network (requires wireless access point or 3G modem)
- Use as a modular, real-time analyzer by connecting the same LAN-XI hardware to a computer

Features

- Small and rugged solid state memory card has no shock-sensitive moving parts like tape recorders or PC hard drives
- Simple start and stop control on the module
- Available memory and overload displayed on the module's built-in LCD screen
- Built-in home page allows any PC, PDA or smartphone with web browser to be used as remote (may require wireless access point or 3G modem)
- Data can be transferred over LAN connection, or the memory card can be removed and inserted in a PC card reader
- Extremely long operating time: >7 hours when used together with LAN-XI Battery Module Type 2831-A

Expanding on the LAN-XI platform, LAN-XI Notar BZ-7848-A allows you to record time data from a single LAN-XI module to an internal SDHC memory card (up to 32 GB). This means that the LAN-XI module is the entire measurement system, a very small and rugged data recorder.



BZ-7848-A works with all LAN-XI modules except Type 3057-B-030. Furthermore, auxiliary signals and high-speed tacho signals from Type 3056 are **not** supported. It includes 16 GB micro-SD card UL-1018. Stored data can be either transferred by placing the memory card in a PC card reader or downloading over the LAN connection.

The recorder is set up (for example, bandwidth, number of channels, signal conditioning, etc.) through the module's home page. This means that any PC, PDA or smartphone with browser can be used (may require wireless access point or 3G modem).

Once the recorder is set up, the PC, PDA or smartphone web browser can control recording and display feedback. The LAN-XI module's button and LCD screen can also be used for control and feedback. Since there is no need to change channel input ranges, control is much simpler than with previous recorders.

The included 16 GB SDHC memory card allows nearly 4 hours of recording with 6 channels at 25.6 kHz bandwidth (51.2 kHz sampling frequency). Micro-SD cards with greater capacity will become available allowing even longer recording sessions. Since the memory card is removable, it is simple to upgrade the memory or use multiple cards. The use of multiple cards allows analysis to begin on recordings while new recordings are made on another.

With the optional battery, Type 2831-A, the system has an extremely long measurement time of over seven hours. For longer recording sessions, the battery can be replaced in the field and chargers are available for both mains and external DC (for example, in-vehicle) charging.

Services

Technical Support

With a Software Maintenance and Support Agreement you get technical support via telephone, email or web conference*. You get direct contact with a knowledgeable and dedicated engineer to help you with:

- Configuration, setup and preparation of projects
- Immediate questions during installation or measurements
- Advice and assistance on post-processing tasks

Accredited Calibration

We recommend you have your system calibrated regularly (annually or every second year) in order to:

- Know if values have shifted in one of the channels
- Prove measurement traceability
- Prove calibration of the entire measurement chain

Your certificate contains measurement results as well associated uncertainties. With accredited calibration from Brüel & Kjær you have proof that calibration has been performed according to quality requirements in ISO 17025. To start the measurement history from day one, we recommend that you order accredited calibration with all new instruments.

Hardware Maintenance

Local Brüel & Kjær staff and skilled technicians at the manufacturing site can make sure that your instruments are performing to specifications to maximize the uptime of your instruments by:

- Conformance testing if you need manufacturer's proof that your hardware performs according to specifications
- Repairing or replacing components in your hardware

Battery Module Type 2831-A is designed for many years of service. As with all rechargeable batteries, the service life will depend on usage, and the Li-Ion cells will likely reach the end of their service life before the other components in the battery module. Type 2831-A is a separate module, and can be replaced or refurbished without returning the entire system. Maintenance is more cost effective than purchasing a new battery, reduces waste and ensures that the cells are disposed of in an environmentally friendly way

Service Agreement

With a Service Agreement you can save both time and money. The value of a Service Agreement lies in a combination of the following:

- Assurance that the time your instrument is away for service is minimized
- Attractive total service price

You can combine a range of services in one agreement over several years. You get priority at the time you need service and predictable maintenance budget. With planned service your instrument is available at the time you set up for measurements and you have proof of correct data.

Should the technician, during calibration, detect the need for repair or replacement, this will be performed while the instrument is with Brüel & Kjær, if covered by the service agreement. You do not

* Check with your local Brüel & Kjær office to hear whether web conference is available in your area

have to be without your instrument several times. There is no delay in communication to decide what should happen with the instrument – and no large surprises to your budget.

Examples of what a Brüel & Kjær Service Agreement can contain:

- Simultaneous maintenance and calibration support
- Multiple calibrations – to give the most favourable price
- Priority calibration
- Priority repair or replacement
- Extension of manufacturer’s warranty

Compliance with Standards

(For environmental specifications and compliance with standards for PCs, see the specifications given by their respective manufacturers)

11-MODULE LAN-XI FRONT-END FRAME TYPE 3660-D-100, 5-MODULE LAN-XI FRONT-END FRAME TYPE 3660-C-100,1-MODULE WIRELESS LAN FRAME TYPE 3660-A-20x, INPUT/OUTPUT MODULES TYPE 3050, 3052, 3053, 3056, 3160 AND 3161, BATTERY MODULE TYPE 2831-A

CE RCM e	The CE marking is the manufacturer's declaration that the product meets the requirements of the applicable EU directives RCM mark indicates compliance with applicable ACMA technical standards – that is, for telecommunications, radio communications, EMC and EME China RoHS mark indicates compliance with administrative measures on the control of pollution caused by electronic information products according to the Ministry of Information Industries of the People's Republic of China WEEE mark indicates compliance with the EU WEEE Directive
Safety	EN/IEC 61010–1 and ANSI/UL 61010–1: Safety requirements for electrical equipment for measurement, control and laboratory use
EMC Emission	**Frames** EN/IEC 61000–6–4: Generic emission standard for industrial environments CISPR 22: Radio disturbance characteristics of information technology equipment. Class A Limits
	Modules EN/IEC 61000–6–3: Generic emission standard for residential, commercial, and light-industrial environments CISPR 22: Radio disturbance characteristics of information technology equipment. Class B Limits
EMC Immunity	EN/IEC61000–6–1: Generic standards – Immunity for residential, commercial and light industrial environments EN/IEC 61000–6–2: Generic standards – Immunity for industrial environments EN/IEC 61326: Electrical equipment for measurement, control and laboratory use – EMC requirements **Note:** The frames and modules fulfil the immunity standards, except **Type 3660-C-100** meets EN 61000–4–2 at ±4 kV air discharge and EN 61000–4–5 surge 1.5 kV line-earth, and **Type 3660-D-100** meets EN 61000–4–2 at ±1 kV air and conduct discharge and EN 61000–4–5 surge ±1.5 kV line-earth **Note:** The above is only guaranteed using accessories listed in this Product Data
Temperature	IEC 60068–2–1 and IEC 60068–2–2: Environmental Testing. Cold and Dry Heat Ambient Operating Temperature: –10 to +55 °C (14 to 131 °F) Storage Temperature: –25 to +70 °C (–13 to +158 °F)
Humidity	IEC 60068–2–78: Damp Heat: 93% RH (non-condensing at 40 °C (104 °F))
Mechanical (non-operating)	**Frames** IEC 60068–2–6: Vibration: 0.3 mm, 2 *g*, 10 – 500 Hz IEC 60068–2–27: Shock: **3660-C-100:** 100 *g*; **3660-D-100:** 50 *g* IEC 60068–2–29: Bump: **3660-C-100:** 1000 bumps at: 25 *g* empty, 15 *g* loaded with modules; **3660-D-100:** 25 *g* loaded with modules
	Modules IEC 60068–2–6: Vibration: 0.3 mm, 2 *g*, 10 – 500 Hz IEC 60068–2–27: Shock: 100 *g* IEC 60068–2–29: Bump: 1000 bumps at: 25 *g*
Enclosure	IEC 60529: Protection provided by enclosures: **3660-C-100, 3660-D-100:** IP 20; **3050, 3052, 3053, 3160, 3161, 2831-A:** IP 31

EFFECT OF RADIATED AND CONDUCTED RF, MAGNETIC FIELD AND VIBRATION

Radiated RF: 80 – 2700 MHz, 80% AM 1 kHz, 10 V/m
Conducted RF: 0.15 – 80 MHz, 80% AM 1 kHz, 10 V
Magnetic Field: 30 A/m, 50 Hz
Vibration: 5 – 500 Hz, 12.7 mm, 15 m/s^2

Input measured with shorted input. All values are RMS. Conducted RF immunity on all channels is only guaranteed using an external connection from measuring ground to chassis terminal

Input/Output	Radiated RF	Conducted RF	Magnetic Field	Vibration
Direct/CCLD	<250 μV	<300 μV	<4 μV	<80 μV
Preamplifier*	<250 μV	<50 μV	<8 μV	<80 μV
Charge (1 nF transducer)†	<10 pC	<3 pC	<0.3 pC	<3 pC
Generator	<250 μV	<50 μV	<2 μV	<5 μV

* Not applicable for Type 3053 †Valid for Type 3161-A-011

Specifications – Types 3660-C-100 and 3660-D-100

POWER REQUIREMENTS
Mains: Wide-range input 90–264 V AC, 47–63 Hz
External Mains Power Connector: Connector type C14 according to IEC/EN 60320–1
DC Input: 11 – 32 V DC
Connector: 4-pole XLR plug
Power Consumption (3660-C-100):
- Starts with 19 W if equipped with 1 LAN-XI module
- Rises to 70 W if equipped with 5 LAN-XI modules
- Maximum power consumption: 90 W

Power Consumption (3660-D-100):
- Starts with 25 W if equipped with 1 LAN-XI module
- Rises to 150 W if equipped with 11 LAN-XI modules
- Maximum power consumption: 200 W

BATTERY CHARGING TIME
Mains: 3 hours to fully charge one or two Type 2831-A batteries
External DC: No charging

DC OUTPUT
+12 V ±1.0 V; max. 1 A (with current protection)
Connector: EIAJ-05 (pin ∅1.4 mm, outer ∅6.5 mm)

LAN
Two connectors type RJ45 8/8, optionally Neutrik® etherCON NE8MC1. Left connector for connection to PC. Right connector includes PoE (IEEE 802.3af) power and is for connection to accessories like PoE cameras or wireless access points (WAP). On Type 3660-C-100, PoE power can be selected on either the first or the second connector

GPS
Connector: SMA

ACOUSTIC NOISE EMISSION

	3660-D-100 dB Lw, A-weighted	3660-C-100 dB Lw, A-weighted
Fan Off	10	5
Normal (22 °C)	32	37
Maximum	48	51

DIMENSIONS
Height: 177.8 mm (7.0″)
Depth: 420.4 mm (16.5″)
Width: 3660-C-100: 224.5 mm (8.8″), **3660-D-100:** 388.5 mm (15.3″)
Weight (frame with mains power supply, etc.)**:**
3660-C-100: 5.3 kg (11.7 lb), **3660-D-100:** 7 kg (15.4 lb)

Specifications – Type 3660-A-20x

Wireless Specifications

ETHERNET
- WAN/LAN × 1, RJ-45 for 10/100 BaseT
- Ethernet and 802.3 with max 10/100 Mbps bit rate and auto cross-over function (MDI-X)

POWER ADAPTOR
AC Input: 100 – 240 V (50 – 60 Hz)
DC Output: 5 V with max. 1 A current

OPERATING FREQUENCY
- 2.4 GHz
- 5 GHz (Types 3660-A-201 and 3660-A-202)

DATA RATE
- IEEE 802.11ac: up to 433 Mbps (Types 3660-A-201 and 3660-A-202)
- IEEE 802.11n: up to 150 Mbps
- IEEE 802.11g: 6-54 Mbps
- IEEE 802.11b: 1-11 Mbps

ENCRYPTION/AUTHENTICATION
Supports 64/128-bit WEP, WPA-PSK, WPA2-PSK

RANGE
The range is similar to a standard WLAN unit, typically from 10 to 50 m (33 to 164 ft), depending on the environment and the number of other WLAN transmitters in the area, for example, smartphones, WiFi, etc

MANAGEMENT
DHCP server
Web-based administration
System event log
Firmware upgrade
Save/restore configuration file

Hardware Specifications

EXTERNAL CASE – DIMENSIONS AND WEIGHT
Length: 48 mm (1.89″)
Width: 53 mm (2.09″)
Height: 131 mm (5.16″)
Weight: 0.29 kg (0.64 lb)

Power Requirements (Type 2831-A)

DC Input: 10 – 32 V DC
Connector: LEMO
Power Consumption (3660-A): ≤12 W (incl. LAN-XI module)

BATTERY CHARGING TIME
With Battery Module set to Active: 3 hours with ZG-0469 mains charger, 4 hours with ZG-0858 DC/In-vehicle charger
Battery Lifetime: Approximately 500 cycles

Wireless Transceiver

TYPE 3660-A-200

Manufacturer:	©ASUSTeK Computer Inc.
Product Name:	5-in-1 Wireless-N150 Mobile Router
Model Name:	WL-330N
Conforms with the essential requirements of the following directives:	
2004/108/EC-EMC Directive	EN 55022:2006+A1:2007 class B EN 61000-3-2:2006+A2:2009 A EN 55024:1998+A1:2001+A2:2003 EN 61000-3-3:2008
1999/5/EC-R & TTE Directive	EN 300 328 V1.7.1(2006-10) EN 301 489-1 V1.8.1(2008-04) EN 301 489-17 V2.1.1(2009-05)
2006/95/EC-LVD Directive	EN 60950-1:2006+A11:2009
2009/125/EC-ErP Directive	EN 62301:2005

TYPES 3660-A-201 AND 3660-A-202

Manufacturer:	Buffalo Inc
Product Name:	AirStation™ AC433 Travel Router
Model Name:	WMR-433-BK

INPUT CHANNELS (DYN-X)

Frequency Range		DC to 51.2 kHz (3050 and 3160) DC to 102.4 kHz (3052) Lower frequency range can be set in PULSE software			
Sampling Rate		**3050, 3160:** 131 ksamples/s; **3052:** 262 ksamples/s			
A/D Conversion		2 × 24 bit			
Data Transfer		24 bit			
Input Voltage Range		10 V_{peak} Extended range: 31.6 V_{peak}			
Input Signal Coupling	**Differential**	Signal ground is "floating" (1 MΩ re: chassis)			
	Single-Ended	Signal ground is connected to chassis ("Grounded")			
Input Impedance		Direct, Microphone: 1 MΩ || < 300 pF			
		CCLD: >100 kΩ || < 300 pF			
Absolute Maximum Input		±60 V_{peak} without damage			
High-pass Filters * Defined as the lower frequency, f_L, for guaranteed fulfilment of −0.1 dB accuracy in 10 V_{peak} range **Defined as the nominal −10%/3 dB filter frequency		**– 0.1 dB** *	**–10**% @ **	**–3 dB** @ **	**Slope**
	0.1 Hz −10% analogue high-pass filter 0.7 Hz −0.1 dB digital high-pass filter	0.5 Hz 0.7 Hz	0.1 Hz 0.15 Hz	0.05 Hz 0.073 Hz	−20 dB/dec.
	1 Hz −10% digital high-pass filter 7 Hz −0.1 dB digital high-pass filter	5 Hz 7 Hz	1.0 Hz 1.45 Hz	0.5 Hz 0.707 Hz	−20 dB/dec.
	22.4 Hz −0.1 dB analogue high-pass filter	22.4 Hz	15.8 Hz	12.5 Hz	−60 dB/dec.
	Intensity filter (analogue)	115 Hz	23.00 Hz	11.5 Hz	−20 dB/dec.
Absolute Amplitude Precision, 1 kHz, 1 V_{input}		±0.05 dB, typ. ±0.01 dB			
Amplitude Linearity (linearity in one range)	0 to 80 dB below full scale	±0.05 dB, typ. ±0.01 dB			
	80 to 100 dB below full scale	±0.2 dB, typ. ±0.02 dB			
	100 to 120 dB below full scale	typ. ±0.02 dB			
	120 to 140 dB below full scale	typ. ±0.02 dB			
	140 to 160 dB below full scale	typ. ±1 dB			
Overall Frequency Response re 1 kHz, from lower limit f_L to upper limit f_U f_L is defined as the lower frequency for guaranteed fulfilment of −0.1 dB accuracy in 10 V_{peak} range (see under High-pass Filters) f_U is defined as the chosen frequency span. DC (f_L = 0)		±0.1 dB ±0.3 dB in 31.6 V range			

Noise (3050 and 3160) * Measured lin. 10 Hz to 25.6 kHz or lin. 10 Hz to 51.2 kHz: (Input terminated by 50 Ω or less)		**Input Range**	**Guaranteed**		**Typical**	
			Lin*	**1 kHz**	**Lin***	**1 kHz**
	Signal level <316 mV_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz	10 V_{peak}	<4 μV_{rms} <13 μV_{rms}	<25 $nV_{rms}/\sqrt{Hz}$	<3 μV_{rms} <10 μV_{rms}	<19 $nV_{rms}/\sqrt{Hz}$
	Signal level >316 mV_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz	10 V_{peak}	<60 μV_{rms} <350 μV_{rms}	<375 $nV_{rms}/\sqrt{Hz}$	<50 μV_{rms} <250 μV_{rms}	<313 $nV_{rms}/\sqrt{Hz}$
	Signal level <1 V_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz	31.6 V_{peak}	<20 μV_{rms} <45 μV_{rms}	<125 $nV_{rms}/\sqrt{Hz}$	<15 μV_{rms} <35 μV_{rms}	<95 $nV_{rms}/\sqrt{Hz}$
	Signal level >1 V_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz	31.6 V_{peak}	<200 μV_{rms} <1200 μV_{rms}	<1250 $nV_{rms}/\sqrt{Hz}$	<150 μV_{rms} <800 μV_{rms}	<950 $nV_{rms}/\sqrt{Hz}$

INPUT CHANNELS (DYN-X) (CONTINUED)

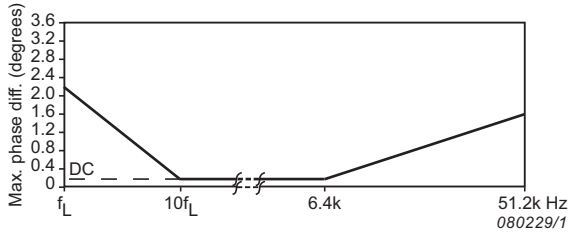
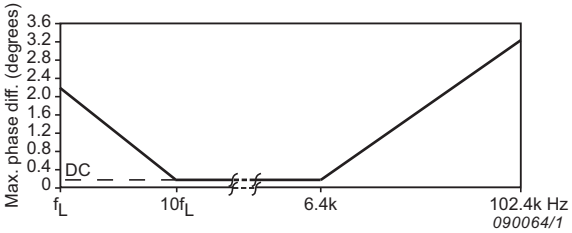
Noise (3052)		**Input Range**	**Guaranteed**		**Typical**	
			Lin*	**1 kHz**	**Lin***	**1 kHz**
* Measured lin. 10 Hz to 51.2 kHz or lin. 10 Hz to 102.4 kHz: (Input terminated by 50 Ω or less)	**Signal level <316 mV_{peak}** 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz 10 Hz to 102.4 kHz	10 V_{peak}	<4 μV_{rms} <6 μV_{rms} <8 μV_{rms}	<25 $nV_{rms}/\sqrt{Hz}$	<3 μV_{rms} <4.5 μV_{rms} <6 μV_{rms}	<19 $nV_{rms}/\sqrt{Hz}$
	Signal level >316 mV_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz 10 Hz to 102.4 kHz	10 V_{peak}	<60 μV_{rms} <85 μV_{rms} <120 μV_{rms}	<375 $nV_{rms}/\sqrt{Hz}$	<50 μV_{rms} <71 μV_{rms} <100 μV_{rms}	<313 $nV_{rms}/\sqrt{Hz}$
	Signal level <1 V_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz 10 Hz to 102.4 kHz	31.6 V_{peak}	<20 μV_{rms} <29 μV_{rms} <40 μV_{rms}	<125 $nV_{rms}/\sqrt{Hz}$	<15 μV_{rms} <22 μV_{rms} <30 μV_{rms}	<95 $nV_{rms}/\sqrt{Hz}$
	Signal level >1V_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz 10 Hz to 102.4 kHz	31.6 V_{peak}	<200 μV_{rms} <285 μV_{rms} <400 μV_{rms}	<1250 $nV_{rms}/\sqrt{Hz}$	<150 μV_{rms} <215 μV_{rms} <300 μV_{rms}	<950 $nV_{rms}/\sqrt{Hz}$

Spurious-free Dynamic Range re Full-scale Input (Input terminated by 50 Ω or less) Spurious-free Dynamic Range is defined as the ratio of the rms full-scale amplitude to the rms value of the largest spurious spectral component (non-harmonic)	**Input Range**	**Typical**
	10 V_{peak}	160 dB
	31.6 V_{peak}	140 dB

DC Offset re Full Scale Measured after automatic DC compensation at current temperature when changing from AC to DC coupling or changing input range when DC coupled	**Model**	**Guaranteed**	**Typical**
	3050 and 3160	<−90 dB	−100 dB
	3052	<−60 dB	−80 dB

Harmonic Distortion (all harmonics)	**Guaranteed**	**Typical**
	−80 dB (−60 dB in 31.6 V range)	−100 dB @ 1 kHz (−80 dB @ 1 kHz in 31.6 V range)

Crosstalk: Between any two channels of a module or between any two channels in different modules, in 10 V input range only	**Frequency Range**	**Guaranteed**	**Typical**
	0 – 51.2 kHz (3050 or 3160) 0 – 100.4 kHz (3052)	−100 dB (−90 dB in 31.6 V range)	−140 dB

Channel-to-Channel Match (10 V_{peak} input range)			**Guaranteed**	**Typical**
	Maximum Gain Difference f_L is defined as the −0.1 dB frequency of the high-pass filter	3050 and 3160	0.2 dB from lower frequency limit, f_L, to 51.2 kHz (0.4 dB at −10% filter frequency)	±0.05 dB
		3052	0.1 dB from lower frequency limit, f_L, to 102.4 kHz (0.4 dB at −10% filter frequency)	±0.01 dB
	3050 and 3160 Maximum Phase Difference (within one frame) f_L is defined as the −0.1 dB frequency of the high-pass filter			
	3052 Maximum Phase Difference (within one frame) f_L is defined as the −0.1 dB frequency of the high-pass filter			
	Additional PTP sync. error (phase difference) between modules/frames (using a single standard gigabit switch)		**Typical:** <200 ns (approx. ±0.07 ° @ 1 kHz, ±2 ° @ 25.6 kHz)	

INPUT CHANNELS (DYN-X) (CONTINUED)

Channel-to-Channel Match (31.6 V_{peak} input range)	Maximum Gain Difference	3050 and 3160	0.6 dB from lower frequency limit, f_L, to 51.2 kHz (1 dB at −10% filter frequency)	
		3052	0.6 dB from lower frequency limit, f_L, to 102.4 kHz (1 dB at −10% filter frequency)	
	Maximum Phase Difference (within one frame)	3050 and 3160	4 ° from lower frequency limit, f_L, to 51.2 kHz	
		3052	4 ° from lower frequency limit, f_L, to 102.4 kHz	

Sound Intensity Phase Match (only for using intensity filter and in 10 V_{peak} input range) All channels matched	**Frequency Range**	**Guaranteed Phase Match**	**Typical Phase Match**
	50 – 250 Hz	±0.017 °	±0.005 °
	250 Hz – 2.5 kHz	0.017 ° × (f/250)	±0.005 °
	2.5 – 6.4 kHz	±0.17 °	±0.08 °
Common Mode Rejection in 10 V_{peak} input range Values for 31.6 V_{peak} range are 10 dB lower		**Guaranteed**	**Typical**
	0 – 120 Hz	70 dB	80 dB
	120 Hz – 1 kHz	55 dB	60 dB
	1 – 51.2 kHz	30 dB	40 dB
	51.2 – 102.4 kHz (3052 only)	30 dB	40 dB

Absolute Max. Common Mode Voltage		±5 V_{peak} without damage
		±4 V_{peak} without clipping (3050, 3160) ±3 V_{peak} without clipping (3052)
		If common mode voltage exceeds the max. value, care must be taken to limit the signal ground current in order to prevent damage. Max. is 100 mA. The instrument will limit the voltage to the stated max. "without damage" common mode value
Anti-aliasing Filter At least 90 dB attenuation of those frequencies which can cause aliasing	Filter Type	3rd order Butterworth
	−0.1 dB @	51.2 kHz or 102.4 kHz (3052)
	−3 dB @	128 kHz or 256 kHz (3052)
	Slope	−18 dB/octave
Supply for Microphone Preamplifiers		±14.0 V, max. 100 mA per channel (max. 100 mA total/module)
Supply for Microphone Polarization		200 V ±1 V, or 0 V (set per channel)
Supply for CCLD		4 to 5 mA from 24 V source, option to DC-couple CCLD power supply
Tacho Supply		CCLD for Type 2981 (Power supply for legacy Types MM-0012 and MM-0024 not available)
Analogue Special Functions		**Microphone Charge Injection Calibration:** All modules with 7-pin LEMO support CIC via dedicated application software and OLE interface **Transducers:** Supports IEEE 1451.4-capable transducers with standardized TEDS (up to 100 m (328 ft) cable length)
Overload Detection		**Signal Overload:** Adjustable detection level ±1 V_{peak} to ±10 V_{peak}. Default level ±10 V_{peak} (CCLD mode ±7 V_{peak}) (31.6 V range: ±31.6 V) can be set in PULSE Transducer Database **CCLD Overload:** Detection of cable break or short-circuit + detection of CCLD transducer working point fault. Detection level: +2 V/20 V **Microphone Preamplifier Overload:** Detection of microphone preamplifier current consumption too high or too low. Detection level default 10 mA/1 mA Adjustable detection level 1 to 20 mA or 100 mA if disabled **Common Mode Voltage Overload:** Detection level: ±3.0 V
Protection		If signal input level exceeds the measuring range significantly, the input will go into protection mode until the signal goes below the detection level again for at least 0.5 s. While in protection mode, the input is partly switched off and the input impedance is greatly increased. (The measured value will be strongly attenuated but still detectable) In DC mode −10 V_{peak} range, the detection limit is ±12 V. In all other measuring modes (except CCLD) the limit is ±50 V_{peak} including DC component or ±12 V_{peak} AC (In CCLD mode the limit is +50/−2 V_{peak} including DC component or ±12 V_{peak} AC) In the 31.6 V range, the limit is ±50 V_{peak}

OUTPUT CHANNELS

Output Connector		2 × BNC	
Output Coupling		DC	
Signal Ground Coupling		Floating or grounded to chassis	
D/A Conversion		24 bit	
DC Offset (DC Value set to 0 V)		≤1 mV auto-adjusted by loopback (<–80 dB re full scale)	
Output Voltage Range (DC)		0 to ±10 V ±0.5% of requested value	
Output Voltage Range (AC)		10 μV_{peak} – 10 V_{peak}	
Output Impedance		50 Ω	
Output Load		Max. 40 mA_{peak}	
Frequency Range		0 – 51.2 kHz	
Frequency Response re 1 kHz		±0.1 dB, 1 mHz to 51.2 kHz	
Frequency Accuracy		0.00025%	
Frequency Resolution		1 mHz (defined in PULSE software)	
Phase Resolution		100 mdegrees (defined in PULSE software)	
Phase Deviation Between Channels		<20 mdegrees for frequencies below 1 kHz*	
Waveform		Software determined arbitrary waveforms up to 2 Msamples Waveforms available in PULSE: Single fixed sine (continuous or burst), single swept sine, dual fixed sine, dual swept sine, fixed sine plus swept sine, stepped sine (with SSR Analyzer), random (continuous or burst), pseudo-random, periodic random User-defined, arbitrary waveforms up to 102.4 kHz can be streamed or downloaded; for 204.8 kHz bandwidth the length is limited to 1 Msample.	
Amplitude Linearity @ 1 kHz		**Guaranteed**	**Typical**
	±0.1 dB	0 – 100 dB below 7 V_{rms}	0 – 110 dB below 7 V_{rms}
Noise		**Guaranteed**	**Typical**
μV_{rms} (nV/√Hz) in 50 kHz bandwidth	up to 316 mV_{peak}	1 μV_{rms} (4.4 nV/√Hz)	0.5 μV_{rms} (2.2 nV/√Hz)
	up to 10 V_{peak}	10 μV_{rms} (44 nV/√Hz)	5 μV_{rms} (22 nV/√Hz)
Harmonic Distortion Products	0 – 51.2 kHz	<–80 dB re full range output	
Spurious In Band (non-harmonic)	0 – 51.2 kHz	<–100 dB re full range output or 1 μV, whichever is greater	
Spurious Out of Band (non-harmonic)	Up to 1 MHz	<–80 dB re full range output	
Absolute Amplitude Precision		**Guaranteed**	
	@ 23 °C, 1 kHz, 1 V_{rms}	±0.05 dB	
Crosstalk		**Guaranteed**	**Typical**
Between output channels and between any output channel and any input channel terminated by less than 50 Ω (unloaded generator output)	0 – 51.2 kHz	–120 dB	–130 dB
Common Mode Rejection		**Guaranteed**	
	1 Hz – 1 kHz	60 dB	
Maximum Common Mode Voltage		5 V_{peak}, DC – 80 MHz If common mode voltage exceeds the max. value, care must be taken to limit the signal ground current in order to prevent damage. Max. is 100 mA. The instrument will limit the voltage to the stated max. "without damage" common mode value	
Reconstruction Filter		Sixth order Butterworth (–3 dB frequency = 120 kHz typically)	
Attenuation of Mirror Frequencies		>80 dB	
Overload Detection		Reported to PULSE and indicated by light rings on output connectors for output voltage above 11 V_{peak} and output current above 40 mA_{peak}	

* Signal generators are not synchronized between LAN-XI and IDA^e generator modules. This does not affect continuous signals (random, white- or pink-noise) but is not suitable for burst random signals and sine signals requiring phase control between generators

POWER REQUIREMENTS
DC Input: 10 – 32 V DC
Connector: LEMO coax., FFA.00.113, ground on shield
Power Consumption:
DC Input: <15 W
Supply via PoE: According to IEEE 802.3af, Max. cable length 100 m (328 ft)
Temperature Protection:
Temperature sensor limits module's internal temperature to 80 °C (176 °F). If temperature exceeds limit, system will automatically enable fan in LAN-XI frame or shut down module outside frame

LAN
Connector type RJ45

DIMENSIONS AND WEIGHT
Height: 132.6 mm (5.22")
Width: 27.5 mm (1.08")
Depth: 248 mm (9.76")
Weight: 750 g (1.65 lb)

DIRECT/MICROPHONE PREAMPLIFIER INPUT

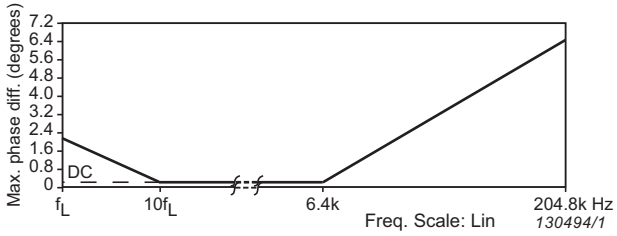
Frequency Range		DC to 204.8 kHz Lower frequency range can be set in PULSE software			
Sampling Rate		524 ksamples/s			
A/D Conversion		2 × 24 bit			
Data Transfer		24 bit			
Input Voltage Range		10 V_{peak} Extended range: 31.6 V_{peak}			
Input Signal Coupling	Differential	Signal ground is "floating" (1 MΩ re: chassis)			
	Single-Ended	Signal ground is connected to chassis ("Grounded")			
Input Impedance		Direct, Microphone: 1 MΩ || <300 pF			
		CCLD: >100 kΩ || <300 pF			
Absolute Maximum Input		±60 V_{peak} without damage			
High-pass Filters * Defined as the lower frequency, f_L, for guaranteed fulfilment of −0.1 dB accuracy in 10 V_{peak} range ** Defined as the nominal −10%/3 dB filter frequency		**– 0.1 dB ***	**–10% @ ****	**–3 dB @ ****	**Slope**
	0.1 Hz −10% analogue high-pass filter	0.5 Hz	0.1 Hz	0.05 Hz	−20 dB/dec.
	7 Hz −0.1 dB digital high-pass filter	7 Hz	1.45 Hz	0.707 Hz	−20 dB/dec.
	22.4 Hz −0.1 dB analogue high-pass filter	22.4 Hz	15.8 Hz	12.5 Hz	−60 dB/dec.
Absolute Amplitude Precision, 1 kHz, 1 V_{input}		±0.05 dB, typ. ±0.01 dB			
Amplitude Linearity (linearity in one range)	0 to 80 dB below full scale	±0.05 dB, typ. ±0.01 dB			
	80 to 100 dB below full scale	±0.2 dB, typ. ±0.02 dB			
	100 to 120 dB below full scale	typ. ±0.02 dB			
	120 to 140 dB below full scale	typ. ±0.02 dB			
	140 to 160 dB below full scale	typ. ±1 dB			
Overall Frequency Response re 1 kHz, from lower limit f_L to upper limit f_U f_L is defined as the lower frequency for guaranteed fulfilment of −0.1 dB accuracy in 10 V_{peak} range (see under High-pass Filters) f_u is defined as the chosen frequency span. DC (f_L = 0)		0 to 102.4 kHz: ±0.1 dB 0 to 204.8 kHz: ±0.25 dB ±0.3 dB in 31.6 V range			

Noise (Input terminated by 50 Ω or less)		**Input Range**	**Guaranteed**		**Typical**	
			Lin	**@ 1 kHz**	**Lin**	**@ 1 kHz**
	Signal level <316 mV_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz 10 Hz to 102.4 kHz 10 Hz to 204.8 kHz	10 V_{peak}	<4 μV_{rms} <6 μV_{rms} <8 μV_{rms} <12 μV_{rms}	<25 $nV_{rms}/\sqrt{Hz}$	<3 μV_{rms} <4.5 μV_{rms} <6 μV_{rms} <8.5 μV_{rms}	<19 $nV_{rms}/\sqrt{Hz}$
	Signal level >316 mV_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz 10 Hz to 102.4 kHz 10 Hz to 204.8 kHz	10 V_{peak}	<60 μV_{rms} <85 μV_{rms} <120 μV_{rms} <170 μV_{rms}	<375 $nV_{rms}/\sqrt{Hz}$	<50 μV_{rms} <71 μV_{rms} <100 μV_{rms} <150 μV_{rms}	<313 $nV_{rms}/\sqrt{Hz}$
	Signal level <1 V_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz 10 Hz to 102.4 kHz 10 Hz to 204.8 kHz	31.6 V_{peak}	<20 μV_{rms} <29 μV_{rms} <40 μV_{rms} <60 μV_{rms}	<125 $nV_{rms}/\sqrt{Hz}$	<15 μV_{rms} <22 μV_{rms} <30 μV_{rms} <44 μV_{rms}	<95 $nV_{rms}/\sqrt{Hz}$
	Signal level >1V_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz 10 Hz to 102.4 kHz 10 Hz to 204.8 kHz	31.6 V_{peak}	<200 μV_{rms} <285 μV_{rms} <400 μV_{rms} <600 μV_{rms}	<1250 $nV_{rms}/\sqrt{Hz}$	<150 μV_{rms} <215 μV_{rms} <300 μV_{rms} <450 μV_{rms}	<950 $nV_{rms}/\sqrt{Hz}$

Spurious-free Dynamic Range re Full-scale Input (Input terminated by 50 Ω or less) Spurious-free Dynamic Range is defined as the ratio of the rms full-scale amplitude to the rms value of the largest spurious spectral component (non-harmonic)	**Input Range**	**Typical**
	10 V_{peak}	160 dB
	31.6 V_{peak}	140 dB

DC Offset re Full Scale Measured after automatic DC compensation at current temperature when changing from AC to DC coupling or changing input range when DC coupled	**Guaranteed**	**Typical**
	<−60 dB	−80 dB

DIRECT/MICROPHONE PREAMPLIFIER INPUT (CONTINUED)

Harmonic Distortion Products		**Guaranteed**	**Typical**	
	10 V range, 1st harmonic < 5 V_p	−80 dB or <1 μV, whichever is greater	−100 dB @ 1 kHz	
	10 V range, 1st harmonic > 5 V_p	−70 dB	−80 dB @ 1 kHz	
	31.6 V range	− 60 dB	−80 dB @ 1 kHz	
Crosstalk:		**Frequency Range**	**Guaranteed**	**Typical**
	From Output channel to Direct/ Preamp/ Charge Input channel	0 – 204.8 kHz	−100 dB	−140 dB
	From Direct/Mic. Preamp. to Charge (if BNC/ Lemo connectors are connected during Charge measurement) Not recommended. Leave the connectors open	0 – 10 kHz 10 – 204.8 kHz	−100 dB −60 dB	−120 dB −70 dB
	From Charge to Direct/Mic. Preamp. (if Charge signal is connected during Direct/ Preamp measurement). Not recommended. Leave the Charge input open	0 – 10 kHz 10 – 204.8 kHz	−70 dB −60 dB	−80 dB −70 dB
Channel-to-Channel Match (10 V_{peak} input range)		**Guaranteed**	**Typical**	
	Maximum Gain Difference f_L is defined as the −0.1 dB frequency of the high-pass filter	0.1 dB from lower frequency limit, f_L, to 102.4 kHz (0.4 dB at −10% filter frequency)	±0.01 dB	
	Maximum Phase Difference (within one frame) f_L is defined as the −0.1 dB frequency of the high-pass filter			
	Additional PTP sync. error (phase difference) between modules/frames (using a single standard gigabit switch)	**Typical:** <200 ns (approx. ±0.07° @ 1 kHz, ±2° @ 25.6 kHz, ±16° @ 200 kHz)		
Channel-to-Channel Match (31.6 V_{peak} input range)	Maximum Gain Difference	0.7 dB from lower frequency limit, f_L, to 204.8 kHz (1 dB at −10% filter frequency)		
	Maximum Phase Difference (within one frame)	8° from lower frequency limit, f_L, to 204.8 kHz		
Common Mode Rejection in 10 V_{peak} input range		**Guaranteed**	**Typical**	
Values for 31.6 V_{peak} range are 10 dB lower	0 – 120 Hz	70 dB	80 dB	
	120 Hz – 1 kHz	60 dB	65 dB	
	1 – 10 kHz	40 dB	45 dB	
	10 – 100 kHz	20 dB	40 dB	
Absolute Max. Common Mode Voltage		±15 V_{peak} without damage		
		±10 V_{peak} without clipping		
		If common mode voltage exceeds the max. value, care must be taken to limit the signal ground current in order to prevent damage. Max. is 100 mA. The instrument will limit the voltage to the stated max. "without damage" common mode value		
Anti-aliasing Filter At least 90 dB attenuation of those frequencies which can cause aliasing	Filter Type	3rd order Butterworth		
	−0.1 dB @	204.8 kHz		
	−3 dB @	512 kHz		
	Slope	−18 dB/octave		
Supply for Microphone Preamplifiers		±33 V or ±15 V, max. 100 mA		
Supply for Microphone Polarization		200 V ±1 V, or 0 V (set per channel)		
Supply for CCLD		7 to 12 mA from 24 V source, option to DC-couple CCLD power supply		
Tacho Supply		CCLD for Type 2981 (Power supply for legacy types MM-0012 and MM-0024 not available)		
Analogue Special Functions	**Microphone Charge Injection Calibration:** All modules with 7-pin LEMO support CIC via dedicated application software and OLE interface **Transducers:** Supports IEEE 1451.4-capable transducers with standardised TEDS (up to 100 m (328 ft) cable length)			

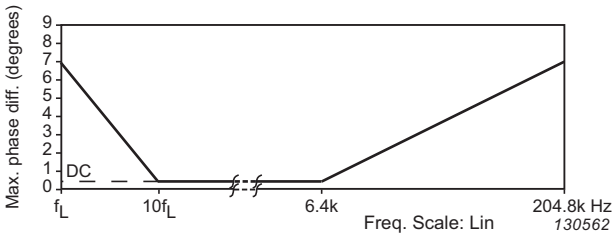
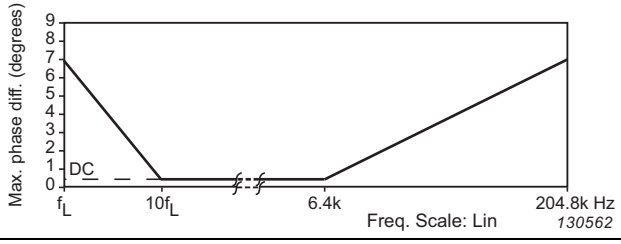
DIRECT/MICROPHONE PREAMPLIFIER INPUT (CONTINUED)

Overload Detection	**Signal Overload:** Adjustable detection level ±1 V_{peak} to ±10 V_{peak}. Default level ±10 V_{peak} (CCLD mode ±7 V_{peak}) (31.6 V range: ±31.6 V) can be set in PULSE Transducer Database. Charge: ±10 V = ±10 nC **CCLD Overload:** Detection of cable break or short-circuit + detection of CCLD transducer working point fault. Detection level: +2 V/20 V **Microphone Preamplifier Overload:** Detection of microphone preamplifier current consumption too high or too low. Detection level default 10 mA/1 mA Adjustable detection level 1 to 20 mA or 100 mA if disabled **Common Mode Voltage Overload:** Detection level: ±10 V
Protection	If signal input level exceeds the measuring range significantly, the input will go into protection mode until the signal goes below the detection level again for at least 0.5 s. While in protection mode, the input is partly switched off and the input impedance is greatly increased. (The measured value will be strongly attenuated but still detectable) In DC mode −10 V_{peak} range, the detection limit is ±12 V. In all other measuring modes (except CCLD) the limit is ±50 V_{peak} including DC component or ±12 V_{peak} AC (In CCLD mode the limit is +50/−2 V_{peak} including DC component or ±12 V_{peak} AC) In the 31.6 V range, the limit is ±50 V_{peak}

CHARGE INPUT

Frequency Range		0.1 Hz to 204.8 kHz Lower frequency range can be set in PULSE software			
Sampling Rate		524 ksamples/s			
A/D Conversion		2 × 24 bit			
Data Transfer		24 bit			
Input Range		10 nC_{peak}			
Input Signal Ground Coupling		Floating or single-ended (grounded to chassis)			
Absolute Maximum Input		±300 nC_{peak} without damage			
High-pass Filters * Defined as the lower frequency, f_L, for guaranteed fulfilment of −0.1 dB accuracy in 10 V_{peak} range ** Defined as the nominal −10%/3 dB filter frequency		**– 0.1 dB ***	**–10% @ ****	**–3 dB @ ****	**Slope**
	0.1 Hz −20% high-pass filter	0.44 Hz	0.14 Hz (– 20% @ 0.1 Hz)	0.074 Hz	−40 dB/dec.
	1 Hz −10% high-pass filter	3.1 Hz	1.0Hz	0.47 Hz	−20 dB/dec.
	7 Hz −0.1 dB high-pass filter	7 Hz	1.45 Hz	0.707 Hz	−20 dB/dec.
	22.4 Hz −0.1 dB high-pass filter	22.4 Hz	15.8 Hz	12.5 Hz	−60 dB/dec.
Absolute Amplitude Precision, 1 kHz, 1 V_{input}		±0.05 dB, typ. ±0.01 dB			
Amplitude Linearity (linearity in one range)	0 to 60 dB below full scale	±0.05 dB, typ. ±0.01 dB			
	60 to 80 dB below full scale	±0.05 dB, typ. ±0.01 dB			
	80 to 100 dB below full scale	±0.2 dB, typ. ±0.02 dB			
	100 to 120 dB below full scale	typ. ±0.02 dB			
	120 to 140 dB below full scale	typ. ±0.02 dB			
	140 to 160 dB below full scale	typ. ±1 dB			
Overall Frequency Response re 1 kHz, from lower limit f_L to 204.8 kHz		10f_L to 25.6 kHz: ±0.1 dB, –10% at f_L and 204.8 kHz			
Noise: Measured lin. 10 Hz to 204.8 kHz **fC_{rms} (input terminated by 1 nF)** (Values in parentheses are specified in $aC_{rms}/\sqrt{Hz}$ [$a = 10^{-18}$]) @1 kHz		**Signal Level**	Guaranteed	Typical	
		<316 pC_{peak}	<20 (<44)	<14 (<32)	
		>316 pC_{peak}	<250 (<550)	<200 (<440)	
Spurious-free Dynamic Range re Full-scale Input (Input terminated by 1 nF)		**Typical**			
		150 dB			
DC Offset re Full Scale		Not applicable			
Harmonic Distortion Products (first harmonic < 5 nC_p)	**1st Harmonic**	**Guaranteed**	**Typical**		
	0.1 Hz – 25.6 kHz	−80 dB	−100 dB @ 1 kHz/1 nC		
	0.1 Hz – 51.2 kHz	−70 dB			
	0.1 Hz – 102.4 kHz	– 65 dB			
Crosstalk: Between input and output channels of a module or between any two channels in different modules Not applicable if using Front Panel UA-2117 as a multiplexer		**Frequency Range**		**Guaranteed**	**Typical**
		0 – 25.6 kHz		−96 dB	−120 dB
		25.6 – 204.8 kHz		−86 dB	−120 dB

CHARGE INPUT (CONTINUED)

Channel-to-Channel Match (same input range)		**Guaranteed**	**Typical**
	Maximum Gain Difference	0.1 dB from 3 × lower frequency limit, f_L, to 1/3 upper limit, f_U 0.8 dB at f_L, 0.4 dB at f_U	±0.01 dB
	Maximum Phase Difference (within one frame)		
Channel-to-Channel Match (any input range)		**Guaranteed**	**Typical**
	Maximum Gain Difference	0.2 dB from 3 × lower frequency limit, f_L, to 1/3 upper limit, f_U 1dB at f_L, 0.5 dB at f_U	±0.02 dB
	Maximum Phase Difference (within one frame)		

Common Mode Rejection		**Guaranteed**
	50 – 120 Hz	40 dB (equal to 10 pC/V)
	120 Hz – 1 kHz	40 dB (equal to 10 pC/V)
	1 – 25 kHz	30 dB (equal to 32 pC/V)
Absolute Max. Common Mode Voltage		±15 V_{peak} without damage
		±10 V_{peak} without clipping)
		If common mode voltage exceeds the max. value, care must be taken to limit the signal ground current in order to prevent damage. Max. is 100 mA. The instrument will limit the voltage to the stated max. "without damage" common mode value
Anti-aliasing Filter At least 90 dB attenuation of those frequencies which can cause aliasing	Filter Type	3rd order Butterworth
	–0.1 dB @	204.8 kHz
	–3 dB @	512 kHz
	Slope	–18 dB/octave
Analogue Special Functions		Analogue Self-test: Functional check
Overload Detection		Signal Overload Common Mode Voltage Overload

OUTPUT

Output Connector	BNC
Output Coupling	DC
Signal Ground Coupling	Floating or grounded to chassis
D/A Conversion	24 bit
DC Offset (DC Value set to 0 V)	≤1 mV auto-adjusted by loopback (<–80 dB re full scale)
Output Voltage Range (DC)	0 to ±10 V ±0.5% of requested value
Output Voltage Range (AC)	10 μV_{peak} – 10 V_{peak}
Output Impedance	50 Ω
Output Load	Max. 40 mA_{peak}
Frequency Range	0 – 204.8 kHz
Frequency Response re 1 kHz	±0.1 dB, 1 mHz to 102.4 kHz ±0.3 dB, 102.4 kHz to 204.8 kHz
Frequency Accuracy	0.00025%
Frequency Resolution	1 mHz (defined in PULSE software)

OUTPUT (CONTINUED)

Phase Resolution		100 mdegrees (defined in PULSE software)	
Phase Deviation Between Channels		<20 mdegrees for frequencies below 1 kHz*	
Waveform		Software determined arbitrary waveforms up to 2 Msamples Waveforms available in PULSE: Single fixed sine (continuous or burst), single swept sine, dual fixed sine, fixed sine plus swept sine, stepped sine (with SSR Analyzer), random (continuous or burst), pseudo-random, periodic random User-defined, arbitrary waveforms can be downloaded	
Amplitude Linearity @ 1 kHz		**Guaranteed**	**Typical**
	±0.1 dB	0 – 100 dB below 7 V_{rms}	0 – 110 dB below 7 V_{rms}
Harmonic Distortion Products	1st harmonic < 51.2 kHz	<–80 dB or <1 μV, whichever is greater	
	1st harmonic 51.2 – 204.8 kHz	<–76 dB or <3 μV, whichever is greater	
Spurious In Band (non-harmonic)	0 – 204.8 kHz	1 μV	
Spurious Out of Band (non-harmonic)	Up to 1 MHz	<–80 dB re full range output	
Absolute Amplitude Precision		**Guaranteed**	
	@ 23°C, 1 kHz, 1 V_{rms}	±0.05 dB	
Crosstalk:	Range	**Guaranteed**	**Typical**
From input channel to output channels of a module	0 – 204.8 kHz	–100 dB	–140 dB
Common Mode Rejection		**Guaranteed**	
	1 Hz – 1 kHz	50 dB	
Maximum Common Mode Voltage		±15 V_{peak}, DC – 80 MHz If common mode voltage exceeds the max. value, care must be taken to limit the signal ground current in order to prevent damage. Max. is 100 mA. The instrument will limit the voltage to the stated max. "without damage" common mode value	
Reconstruction Filter		Third order Butterworth (–3 dB frequency = 485 kHz typically, –0.1 dB @ 255 kHz)	
	Attenuation of Mirror Frequencies	>80 dB	
	Overload Detection	Reported to PULSE and indicated by light rings on output connectors for output voltage above 11 V_{peak} and output current above 40 mA_{peak}	
	Monitor Output	$V_{out} = V_{in}$ – signal taken after analogue high-pass filters and input differential amplifier removing common mode signals and CCLD working voltage (≈12 V DC) in CCLD mode	

* Signal generators are not synchronized between LAN-XI and IDA^e generator modules. This does not affect continuous signals (random, white-noise) but is not suitable for burst random signals and sine signals requiring phase control between generators

POWER REQUIREMENTS
DC Input: 10–32 V DC
Connector: LEMO coax., FFA.00.113, ground on shield
Power Consumption:
DC Input: <15 W
Supply via PoE: According to IEEE 802.3af,
Max. cable length 100 m (328 ft)

Temperature Protection:
Temperature sensor limits module's internal temperature to 80 °C (176 °F). If temperature exceeds limit, system will automatically enable fan in LAN-XI frame or shut down module outside frame

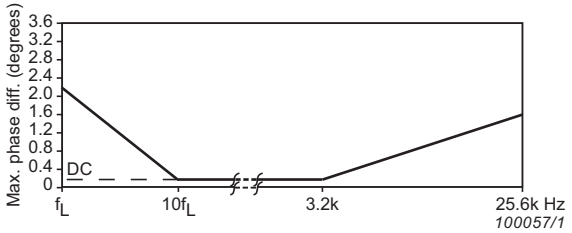
DIMENSIONS AND WEIGHT
Height: 132.6 mm (5.22")
Width: 27.5 mm (1.08")
Depth: 248 mm (9.76")
Weight: 750 g (1.65 lb)

Specifications – Type 3053

INPUT CHANNELS

Frequency Range		DC to 25.6 kHz or any range defined by high-pass filters and by software decimation set in "frequency span"
Sampling Rate		65.5 ksamples/s
Data Transfer		24 bit
Input Voltage Range		1 V_{peak} 10 V_{peak}
Input Signal Coupling	**Differential**	Signal ground is "floating" (1 MΩ re chassis)
	Single-Ended	Signal ground is connected to chassis ("Grounded")

INPUT CHANNELS (CONTINUED)

Input Impedance			Direct: 1 MΩ || <300 pF		
			CCLD: >100 kΩ || <300 pF		
Absolute Maximum Input			±60 V_{peak} without damage		
High-pass Filters * defined as the lower frequency, f_L, for guaranteed fulfilment of –0.1dB accuracy ** defined as the nominal –10% / –3dB filter frequency *** single analogue pole + 2nd order digital filter section		**– 0.1 dB** *	**–10%** @ **	**–3 dB** @ **	**Slope**
	0.1 Hz –10% digital high-pass filter	0.5 Hz	0.1 Hz	0.05 Hz	–20 dB/dec.
	0.7 Hz –0.1 dB digital high-pass filter	0.7 Hz	0.15 Hz	0.073 Hz	
	1 Hz analogue –10% high-pass filter	5 Hz	1.0 Hz	0.5 Hz	–20 dB/dec.
	7 Hz –0.1dB digital high-pass filter	7 Hz	1.45 Hz	0.707 Hz	
	22.4 Hz –0.1 dB analogue*** high-pass filter	22.4 Hz	14.64 Hz	11.5 Hz	–60 dB/dec.
	Intensity filter (analogue)	112 Hz	23.00 Hz	11.2 Hz	–20 dB/dec.
Absolute Amplitude Precision, 1 kHz, 1 V_{input}			±0.05 dB, typical ±0.01 dB		
Amplitude Linearity (linearity in one range)	0 to 60 dB below full scale		±0.1 dB, typ. ±0.01 dB		
	60 to 80 dB below full scale		±0.2 dB, typ. ±0.02 dB		
	80 to 100 dB below full scale		typ. ±0.05 dB		
Overall Frequency Response re 1 kHz, from lower limit f_L to upper limit f_U f_L is defined as the lower frequency for guaranteed fulfilment of –0.1 dB accuracy (see under High-pass Filters) f_U is defined as the chosen frequency span			±0.1 dB		
Noise: **Measured lin. 10 Hz to 25.6 kHz** (input terminated by 50 Ω or less)	**Input Range**		**Guaranteed**		**Typical**
	1 V_{peak}		<7.5 µV_{rms} (<47 nV_{rms}/√Hz @ 1 kHz)		<5.5 µV_{rms} (<35 nV_{rms}/√Hz @ 1 kHz)
	10 V_{peak}		<75 µV_{rms} (<470 nV_{rms}/√Hz @ 1kHz)		<55 µV_{rms} (<350 nV_{rms}/√Hz @ 1 kHz)
Spurious-free Dynamic Range re full scale input (input terminated by 50 Ω or less) Spurious-free Dynamic Range is defined as: The ratio of the rms full scale amplitude to the rms value of the peak non-harmonic spectral component	Input Range		**Typical**		
	1 V_{peak}		130 dB		
	10 V_{peak}		130 dB 120 dB with DC coupling		
DC Offset re Full Scale Measured after automatic DC compensation at current temperature when changing from AC to DC coupling or changing input range when DC coupled			**Guaranteed**		**Typical**
			<–80 dB		<–90 dB
Harmonic Distortion (all harmonics)			**Guaranteed**		**Typical**
			–80 dB in 1 V range –75 dB in 10 V range		–100 dB @ 1 kHz
Crosstalk Between any two channels of a module or between any two channels in different modules			**Frequency Range**	**Guaranteed**	**Typical**
			0 – 25.6 kHz	–80 dB	–100 dB
Channel-to-Channel Match (10 V_{peak} and 1 V_{peak} input ranges)			**Guaranteed**		**Typical**
	Maximum Gain Difference f_L is defined as the –0.1 dB filter frequency		0.1 dB from lower frequency limit, f_L, to 25.6 kHz (0.4 dB at –10% filter frequency)		±0.01 dB
	Maximum Phase Difference (within one frame) f_L is defined as the –0.1dB filter frequency				
Sound Intensity Phase Match			Not relevant		

INPUT CHANNELS (CONTINUED)

Common Mode Rejection		**Guaranteed**		**Typical**	
		10V range	**1V range**	**10V range**	**1V range**
	0.1 Hz – 120 Hz	60 dB	80 dB	65 dB	85 dB
	120 Hz – 1 kHz	50 dB	70 dB	55 dB	75 dB
	1 kHz – 25.6 kHz	30 dB	50 dB	40 dB	60 dB
Absolute Max. Common Mode Voltage		±5 V_{peak} without damage			
		±3 V_{peak} without clipping			
		If common mode voltage exceeds the max. value, care must be taken to limit the signal ground current in order to prevent damage. Maximum is 100 mA. The instrument will limit the voltage to the stated max. "without damage" common mode value			
Anti-aliasing Filter At least 90 dB attenuation of those frequencies which can cause aliasing	Filter Type	3rd order Butterworth			
	–0.1 dB @	25.6 kHz			
	–3 dB @	64 kHz			
	Slope	–18 dB/octave			
Supply for Microphone Preamplifiers		Not available			
Supply for Microphone Polarization		Not available			
Supply for CCLD		3.6 mA from 24 V source			
		If any CCLD-coupled channel is paralleled with another channel, this must also be CCLD-coupled. Otherwise the signal might be clipped by the paralleled channel			
Tacho Supply		CCLD for Type 2981 (Power supply for legacy types MM-0012 and MM-0024 not available)			
Analogue Special Functions		**Transducers:** Supports IEEE 1451.4 capable transducers with standardized TEDS			
Overload Detection		**Signal overload:** Detection level in 1 V range: ±1 V_{peak} in 10 V range: ±10 V_{peak} (in CCLD mode: ±7 V_{peak}) **CCLD overload:** Detection of cable break or short-circuit + detection of CCLD transducer working point fault. Detection level: +2 V/20 V **Common mode voltage overload** Detection level: ±3 V **Protection:** If signal input level exceeds the measuring range significantly, the input will go into protection mode until the signal goes beyond the detection level again – but at least for 0.5 s. While in protection mode the input is partly switched off and the input impedance is strongly increased. (The measured value will be strongly attenuated but still detectable) **Detection level:** Direct mode: ±33 V_{peak}, CCLD mode: +27/ –2 V_{peak}			

POWER REQUIREMENTS
DC Input: 10 – 32 V DC
Connector: LEMO coax., FFA.00.113, ground on shield
Power Consumption:
DC Input: <15 W
Typical Operating Time on Battery Type 2831-A:
>7 hours with single module
>40 minutes in Type 3660-D-100 frame (up to two batteries in Type 3660-D-100)
Supply via PoE: According to IEEE 802.3af, Max. cable length 100 m (328 ft)

Temperature Protection:
Temperature sensor limits module's internal temperature to 80 °C (176 °F). If temperature exceeds limit, system will automatically enable fan in LAN-XI frame or shut down module outside frame

LAN
Connector type RJ 45

DIMENSIONS AND WEIGHT
Height: 132.6 mm (5.22")
Width: 27.5 mm (1.08")
Depth: 248 mm (9.76")
Weight: 750 g (1.65 lb)

HIGH-SPEED TACHOMETER CHANNELS
Available on channels 1 to 4:

	PULSE LabShop	PULSE Time Data Recorder Type 7708
Ch. 1	High-speed tacho signal or normal input	High-speed tacho signal or normal input
Ch. 2	High-speed tacho ref or normal input	High-speed tacho ref or normal input
Ch. 3	High-speed tacho signal or normal input	Normal input
Ch. 4	High-speed tacho ref or normal input	Normal input

Analogue Bandwidth: >1 MHz @ 5 V_{peak} (TTL level)
Tacho Resolution: 15 ns
Max. Tacho Input Voltage: 10 V_{peak}
Absolute Max. Input Voltage: ±60 V_{peak}
Trigger Level: 0.2 V to 7 V
Default Trigger Level: 1.5 V
Triggering on rising or falling edge

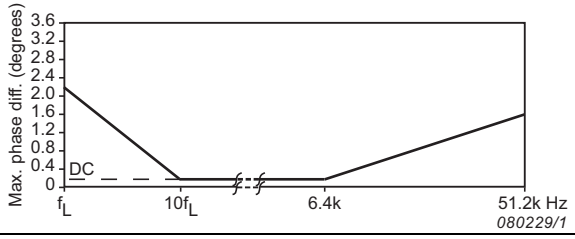
Upper RPM Limit	Max. Pulses/ Revolution	Angular Resolution (°)
1000	60000	0.0000025
6000	10000	0.000015
20000	3000	0.00005
150000	400	0.00375

AUXILIARY INPUT CHANNELS (simultaneously sampled)
Number of Channels: 8 DC channels in 2 × 10-pole LEMO connectors
Input Connector: 2 × 10-pole LEMO
Sampling Rate: 16 Hz
Input Connection: Single-ended
Input Voltage Range: ±10 V in one range
Input Protection: 50 V
Input Impedance: 1 MΩ || 300pF
Precision: ±0.1% of reading ±1 mV offset (after warm up time)
Noise: <3 µV (10 mHz – 8 Hz) measured without temperature drift and DC offset
Noise-free Dynamic Range: 120 dB (typical)
Noise-free Resolution: 19 to 20 bits (typical)
Temperature Coefficient: <15 µV/°C (typical)
Distortion: 90 dB @1 Hz 10 V_{peak} (typical)
Programmable DC Output Channels: 4 open-drain outputs (2 per connector) able to sink 100 mA from an external supply of typically 24 V, which allow simple relay control (on/off, pass/fail, etc.) via OLE2 automation interface
DC Output without External Supply: 5 V, max. 50 mA
DC Output Protection: 40 V
DC Out Supply: 5 V out, max. 100 mA total for module

INPUT CHANNELS (DYN-X)

Frequency Range		DC to 51.2 kHz Lower frequency range can be set in PULSE software			
Sampling Rate		131 ksamples/s			
A/D Conversion		2 × 24 bit			
Data Transfer		24 bit			
Input Voltage Range		10 V_{peak} Extended range: 31.6 V_{peak}			
Input Signal Coupling	**Differential**	Signal ground is “floating” (1 MΩ re chassis)			
	Single-Ended	Signal ground is connected to chassis (“Grounded”)			
Input Impedance		Direct, Microphone: 1 MΩ || <300 pF			
		CCLD: >100 kΩ || <300 pF			
Absolute Maximum Input		±60 V_{peak} without damage			
High-pass Filters * Defined as the lower frequency, f_L, for guaranteed fulfilment of −0.1 dB accuracy in 10 V_{peak} range ** Defined as the nominal −10%/3 dB filter frequency		**– 0.1 dB** *	**–10**% @ **	**–3 dB** @ **	**Slope**
	0.1 Hz −10% analogue high-pass filter 0.7 Hz −0.1 dB digital high-pass filter	0.5 Hz 0.7 Hz	0.1 Hz 0.15 Hz	0.05 Hz 0.073 Hz	−20 dB/dec.
	1 Hz −10% digital high-pass filter 7 Hz −0.1 dB digital high-pass filter	5 Hz 7 Hz	1.0 Hz 1.45 Hz	0.5 Hz 0.707 Hz	−20 dB/dec.
	22.4 Hz −0.1 dB analogue high-pass filter	22.4 Hz	15.8 Hz	12.5 Hz	−60 dB/dec.
	Intensity filter (analogue)	115 Hz	23.00 Hz	11.5 Hz	−20 dB/dec.
Absolute Amplitude Precision, 1 kHz, 1 V_{input}		±0.05 dB, typ. ±0.01 dB			
Amplitude Linearity (linearity in one range)	0 to 80 dB below full scale	±0.05 dB, typ. ±0.01 dB			
	80 to 100 dB below full scale	±0.2 dB, typ. ±0.02 dB			
	100 to 120 dB below full scale	typ. ±0.02 dB			
	120 to 140 dB below full scale	typ. ±0.02 dB			
	140 to 160 dB below full scale	typ. ±1 dB			

INPUT CHANNELS (DYN-X) (CONTINUED)

Overall Frequency Response **re 1 kHz, from lower limit f_L to upper limit f_U** f_L is defined as the lower frequency for guaranteed fulfilment of −0.1 dB accuracy in 10 V_{peak} range (see under High-pass Filters) f_U is defined as the chosen frequency span. DC (f_L = 0)			±0.1 dB ±0.3 dB in 31.6 V range			
Noise		**Input Range**	**Guaranteed**		**Typical**	
			Lin*	**1 kHz**	**Lin***	**1 kHz**
* Measured lin. 10 Hz to 25.6 kHz or lin. 10 Hz to 51.2 kHz: (Input terminated by 50 Ω or less)	**Signal level <316 mV_{peak}** 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz	10 V_{peak}	<4 μV_{rms} <13 μV_{rms}	<25 $nV_{rms}/\sqrt{Hz}$	<3 μV_{rms} <10 μV_{rms}	<19 $nV_{rms}/\sqrt{Hz}$
	Signal level >316 mV_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz	10 V_{peak}	<60 μV_{rms} <350 μV_{rms}	<375 $nV_{rms}/\sqrt{Hz}$	<50 μV_{rms} <250 μV_{rms}	<313 $nV_{rms}/\sqrt{Hz}$
	Signal level <1 V_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz	31.6 V_{peak}	<20 μV_{rms} <45 μV_{rms}	<125 $nV_{rms}/\sqrt{Hz}$	<15 μV_{rms} <35 μV_{rms}	<95 $nV_{rms}/\sqrt{Hz}$
	Signal level >1V_{peak} 10 Hz to 25.6 kHz 10 Hz to 51.2 kHz	31.6 V_{peak}	<200 μV_{rms} <1200 μV_{rms}	<1250 $nV_{rms}/\sqrt{Hz}$	<150 μV_{rms} <800 μV_{rms}	<950 $nV_{rms}/\sqrt{Hz}$
Spurious-free Dynamic Range re Full-scale Input **(Input terminated by 50 Ω or less)** Spurious-free Dynamic Range is defined as the ratio of the rms full-scale amplitude to the rms value of the largest spurious spectral component (non-harmonic)		**Input Range**	**Typical**			
		10 V_{peak}	160 dB			
		31.6 V_{peak}	140 dB			
DC Offset re Full Scale Measured after automatic DC compensation at current temperature when changing from AC to DC coupling or changing input range when DC coupled			**Guaranteed**		**Typical**	
			<−90 dB		−100 dB	
Harmonic Distortion (all harmonics)			**Guaranteed**		**Typical**	
			−80 dB (−60 dB in 31.6 V range)		−100 dB @ 1 kHz (−80 dB @ 1 kHz in 31.6 V range)	
Crosstalk: Between any two channels of a module or between any two channels in different modules			**Frequency Range**		**Guaranteed**	**Typical**
			0 to 51.2 kHz		−100 dB	−140 dB
Channel-to-Channel Match **(10 V_{peak} input range)**			**Guaranteed**		**Typical**	
	Maximum Gain Difference f_L is defined as the −0.1 dB frequency of the high-pass filter		0.2 dB from lower frequency limit, f_L, to 51.2 kHz (0.4 dB at −10% filter frequency)		±0.05 dB	
	Maximum Phase Difference (within one frame) f_L is defined as the −0.1 dB frequency of the high-pass filter					
	Additional PTP sync. error (phase difference) between modules/frames (using a single standard gigabit switch)		**Typical:** <200 ns (approx. ±0.07 ° @ 1 kHz, ±2 ° @ 25.6 kHz)			
Channel-to-Channel Match **(31.6 V_{peak} input range)**	Maximum Gain Difference		0.6 dB from lower frequency limit, f_L, to 51.2 kHz (1 dB at −10% filter frequency)			
	Maximum Phase Difference (within one frame)		4 ° from lower frequency limit, f_L, to 51.2 kHz			
Sound Intensity Phase Match **(only for using intensity filter and in 10 V_{peak} input range)** All channels matched		**Frequency Range**	**Guaranteed Phase Match**		**Typical Phase Match**	
		50 to 250 Hz	±0.017 °		±0.005 °	
		250 Hz to 2.5 kHz	0.017 ° × (f/250)		±0.005 °	
		2.5 to 6.4 kHz	±0.17 °		±0.08 °	
Common Mode Rejection in 10 V_{peak} input range Values for 31.6 V_{peak} range are 10 dB lower.			**Guaranteed**		**Typical**	
		0 to 120 Hz	70 dB		80 dB	
		120 Hz to 1 kHz	55 dB		60 dB	
		1 to 51.2 kHz	30 dB		40 dB	

INPUT CHANNELS (DYN-X) (CONTINUED)

Absolute Max. Common Mode Voltage		±5 V_{peak} without damage
		±4 V_{peak} without clipping
		If common mode voltage exceeds the max. value, care must be taken to limit the signal ground current in order to prevent damage. Max. is 100 mA. The instrument will limit the voltage to the stated max. "without damage" common mode value
Anti-aliasing Filter At least 90 dB attenuation of those frequencies which can cause aliasing	Filter Type	3rd order Butterworth
	–0.1 dB @	51.2 kHz
	–3 dB @	128 kHz
	Slope	–18 dB/octave
Supply for Microphone Preamplifiers		±14.0 V, max. 100 mA per channel (max. 100 mA total/module)
Supply for Microphone Polarization		200 V ±1 V, or 0 V (set per channel)
Supply for CCLD		4 to 5 mA from 24 V source, option to DC-couple CCLD power supply
Tacho Supply		CCLD for Type 2981 (Power supply for legacy Types MM-0012 and MM-0024 not available)

Analogue Special Functions	**Microphone Charge Injection Calibration:** All modules with 7-pin LEMO support CIC via dedicated application software and OLE interface **Transducers:** Supports IEEE 1451.4-capable transducers with standardized TEDS (up to 100 m (328 ft) cable length)
Overload Detection	**Signal Overload:** Adjustable detection level ±1 V_{peak} to ±10 V_{peak}. Default level ±10 V_{peak} (CCLD mode ±7 V_{peak}) (31.6 V range: ±31.6 V) can be set in PULSE Transducer Database **CCLD Overload:** Detection of cable break or short-circuit + detection of CCLD transducer working point fault. Detection level: +2 V/20 V **Microphone Preamplifier Overload:** Detection of microphone preamplifier current consumption too high or too low. Detection level default 10 mA/1 mA Adjustable detection level 1 to 20 mA or 100 mA if disabled **Common Mode Voltage Overload:** Detection level: ±3.0 V
Protection	If signal input level exceeds the measuring range significantly, the input will go into protection mode until the signal goes below the detection level again for at least 0.5 s. While in protection mode, the input is partly switched off and the input impedance is greatly increased. (The measured value will be strongly attenuated but still detectable) In DC mode –10 V_{peak} range, the detection limit is ±12 V. In all other measuring modes (except CCLD) the limit is ±50 V_{peak} including DC component or ±12 V_{peak} AC In CCLD mode the limit is +50/–2 V_{peak} including DC component or ±12 V_{peak} AC In the 31.6 V range, the limit is ±50 V_{peak}

POWER REQUIREMENTS
DC Input: 10 – 32 V DC
Connector: LEMO coax., FFA.00.113, ground on shield
Power Consumption:
DC Input: <15 W
Supply via PoE: According to IEEE 802.3af, Max. cable length 100 m (328 ft)

Temperature Protection:
Temperature sensor limits module's internal temperature to 80 °C (176 °F). If temperature exceeds limit, system will automatically enable fan in LAN-XI frame or shut down module outside frame

DIMENSIONS AND WEIGHT
Height: 132.6 mm (5.22")
Width: 27.5 mm (1.08")
Depth: 248 mm (9.76")
Weight: 750 g (1.65 lb)

Specifications – LAN-XI Notar BZ-7848-A

NUMBER OF CHANNELS
2 – 12 (hardware module dependent)

RECORDER CONTROL – SETUP
Through an Internet browser on PC, PDA or smartphone (no remote license required) to LAN-XI module's built-in home page:
- Recording name
- Frequency bandwidth of recording
- Duration of recording
- Enable/Disable channels for recording
- Configure channels (for example, sensor power supply, high-pass filter, sensor sensitivity, etc.)

Connection by standard wired LAN or optional through wireless LAN or GSM Modem (requires wireless access point or GSM modem)

RECORDER CONTROL – MEASUREMENT
Stand-alone: Record Start/Stop by pushbutton. Module LCD gives recorder status and amount of storage remaining

Internet Browser: Record Start/Stop. Level indication of each channel, recorder status, amount of storage remaining, current overload status and latched overload status during recording session

SUPPORTED INTERNET BROWSERS
Microsoft® Internet Explorer®, Firefox™ (Windows® and Linux), Safari®, and Chrome™ (also via smartphone)

DATA STORAGE
Format: micro-SD; SDHC memory card (up to 32 GB)*
Included Card: 16 GB micro-SD
File Format: WAV format with additional measurement/channel information stored in Brüel & Kjær footer
Transfer Methods: SD card reader (with included adaptor) or remote via Ethernet connection (> 2 MB/s)

* SDXC memory cards are not supported

Specifications – Battery Module Type 2831-A

Type: Li-Ion rechargeable
Typical Operating Time:>7 hours with single module, >40 minutes in Type 3660-D-100 frame (up to 2 batteries in Type 3660-D-100)
Output Voltage: 14.8 V (nominal)
Capacity: 91 Wh
Status Indicators: 5 LEDs showing remaining capacity on battery, software access to charging status and remaining capacity in LAN-XI frame

Charging Time:
- 3 hours in 3660-C-100 or -D-100 Frame powered from mains
- No charging of batteries when the frame is powered from external DC
- 2 hours with ZG-0469 mains charger
- 3 hours with ZG-0858 DC/In-vehicle charger

DIMENSIONS AND WEIGHT
Height: 132.6 mm (5.22″)
Width: 27.5 mm (1.08″)
Depth: 248 mm (9.76″)
Weight: 1.0 kg (2.2 lb)

Specifications – LAN Interface

CONNECTOR
Modules: RJ 45 (10baseT/100baseTX) connector complying with IEEE 802.3 100baseX. Individual modules communicate at 100 Mbit/s
Frames: Types 3660-C-100 and -D-100 permit the use of a ruggedized RJ45 data connector (Neutrik NE8MC-1) to screw the cable to the frame
Types 3660-C-100 and -D-100 communicate at 1000 Mbit/s. Shielded cables of type "CAT 5e" or better should be used
All LAN connectors support MDIX, which means that cables may be "crossed" or not
For stand-alone modules, PoE is also supported (IEEE 802.3af). PoE requires screened shielded twisted pair (S/STP or S/FTP) CAT6 LAN cables

PROTOCOL
The following standard protocols are used:
- TCP
- UDP
- DHCP (incl. Auto-IP)
- DNS (on top of UDP)
- PTP v2, IEEE 1588–2008 (on top of UDP)
- IP
- http (on top of TCP; for web server, etc.)
- Ethernet (IEEE 802.3 with IEEE 802.3X)

ACQUISITION PERFORMANCE
Each LAN-XI module generates data at almost 20 Mbit/s when acquiring data at maximum bandwidth. The modules are capable of handling their own maximum traffic while the built-in switch in the frame's backplane has more than sufficient capacity. This is very scalable and means that bottlenecks can only occur outside these, for example in:
- External switches
- PC

For convenience, it is possible to daisy-chain two LAN-XI frames. It is not recommended to daisy-chain more than two frames. Generally, a star configuration with a central switch is recommended. This must have a switch capacity well beyond $N \times 20$ Mbit/s, where N is the total number of modules. Be aware that this includes data cascaded from other switches "upstream"

PTP PERFORMANCE
PTP Synchronization (with 1 Gigabit LAN Switch): Typical sample synchronization better than 200 ns
(approx. ±0.07 ° @ 1 kHz, ±2 ° @ 25.6 kHz)
Tested with:
- Cisco® SG300-10MP, 10-port 10/100/1000 Managed Gigabit Switch with Maximum PoE (8 ports)
- Hirschmann PTP switches

Better performance can be expected with a dedicated PTP switch:
- UL-0265: PULSE Measurement System Switch, 8-port LAN switch with PoE and PTPv2 support. This is a dedicated PTP switch, preconfigured for optimal use with LAN-XI

Ordering Information

Type No.*	Name	Accessories Included		Optional Accessories	
3050-A-060	6-ch. Input Module LAN-XI 51.2 kHz (Mic, CCLD, V)	UA-2100-060	Detachable front panel with 6 BNC input connectors	See BP 2421 for a complete overview of front panels	
3050-A-040	4-ch. Input Module LAN-XI 51.2 kHz (Mic, CCLD, V)	UA-2100-040	Detachable front panel with 4 BNC input connectors		
3052-A-030	3-ch. Input Module LAN-XI 102.4 kHz (Mic, CCLD, V)	UA-2100-030	Detachable front panel with 3 BNC input connectors	See BP 2421 for a complete overview of front panels	
3053-B-120	12-channel LAN-XI Module (CCLD, V)	UA-2107-120	LAN-XI Detachable front panel with 12 SMB input connectors	See BP 2421 for a complete overview of front panels	
3056-A-040	4-ch. Input/HS-Tacho + 8-ch. Aux. Module LAN-XI 51.2 kHz (Mic, CCLD, V)	UA-2111-040	Detachable front panel with 4 BNC input connectors and 2 LEMO auxiliary connectors	See BP 2421 for a complete overview of front panels	
3057-B-030	3-ch. Bridge Input Module LAN-XI 102.4 kHz (Bridge, CCLD, V)	UA-2121-030	Detachable front panel with 3 sub-D input connectors	See BP 2421 for a complete overview of front panels	
3160-A-042	Generator, 4/2-ch. Input/Output Module LAN-XI 51.2 kHz (Mic, CCLD, V)	UA-3100-042	Detachable front panel with 6 BNC input/output connectors	See BP 2421 for a complete overview of front panels	
3160-A-022	Generator, 2/2-ch. Input/Output Module LAN-XI 51.2 kHz (Mic, CCLD, V)	UA-2100-022	Detachable front panel with 4 BNC input/output connectors		
3161-A-011	1 ch. Input + 1 ch. Output Module LAN-XI 204.8 kHz (Mic, CCLD, V)	UA-2117-011	Detachable front panel with BNC, LEMO and TNC input connectors	See BP 2421 for a complete overview of front panels	
All Input/Output Modules		ZG-0426 AO-1450	Mains Adaptor (100 – 240 V) Shielded CAT 6 LAN Cable with RJ45 (2 m)		
3660-C-100	5-module LAN-XI Front-end Frame with GPS	Built-in mains power transformer with AN-00xx Ruggedized RJ45 data connector (Neutrik NE8MC-1) Terminator for IDA^{e} Sync (50 Ω) ZZ-0260 GPS antenna (non-magnetic), SMA right-angle, 5 m (16.4 ft)		AO-1490 AO-1489 AO-0087-D-xxx	3660-D-100 Frame DC Power Cable 3660-D-100 Frame DC Power to Car Utility Connector BNC Cable for synchronization of combined LAN-XI and IDA^{e} systems
3660-D-100	11-module LAN-XI Front-end Frame with GPS				
3660-A-20x	1-module Wireless LAN Frame				
2831-A	Battery Module for LAN-XI	ZH-0686 ZG-0469 UA-2106	Single Module to Battery Power Adaptor Mains Charger (100 – 240 V) Power control front	ZG-0858	DC Power Charger with Car Utility Connector
BZ-7848-A	LAN-XI Notar, stand-alone recorder for single module	UL-1018	16 GB micro-SD card	Type 7789-B BZ-7848-A-MS1	PULSE Time bundle including BZ-7848-A Maintenance and Support Contract for BZ-7848-A

* -A- versions are multipurpose input/output modules capable of providing microphone polarization voltage. -B- versions are "CCLD Only" input/output modules

OPTIONAL ACCESSORIES

AO-0090	7-pin LEMO to BNC male (1.2 m) for floating ground
AO-0091	7-pin LEMO to BNC female (1.2 m) for floating ground
AO-0526	4-pin Microtech to 3 × BNC Cable
AO-0546	DC Power Cable, Car Utility Socket to 1 module
AO-0548	DC Power Cable, Source to 4 modules
AO-1450	Shielded CAT 6 LAN Cable with RJ45 (2 m)
AO-0738-D-010	Cable for Type 3056, 2 × 10-pin LEMO (M) to 8 × BNC (F) 1.0 m (3.3 ft.), max. 70 °C (158 °F)
JJ-0081	BNC Adaptor, female to female
JJ-0152	BNC T-connector
JP-0145	BNC to 10−32 UNF plug adaptor
JP-0162	TNC to 10−32 UNF plug adaptors for charge
UA-1713	10 × 2 mm Hex Wrench (QX-1315) for front panel exchange
UL-0265	PULSE Measurement System Switch, 8-port LAN switch with PoE and PTPv2 support
WB-1497	20 dB Attenuator
ZH-0699	Break-out Box (for Type 3056)

SOFTWARE

Please refer to the System Data for PULSE Software (BU 0229)

NOTEBOOK PCs*

7201-G-xxy†,‡	Dell® High-end Notebook
7204-A-xx†	Crete Military Spec Notebook

TOWER PCs*

7202-G-xxy†,‡	Dell® Optiplex 9020 MT Standard Desktop
7203-C-xxy†,‡	Dell® Precision Tower 7910 High-end Tower PC

* PCs are constantly updated. Contact your local dealer for latest information
† xx specifies country: DE, DK, ES, FR, GB, IT, RU, SE, US
‡ y specifies inclusion of Microsoft® Office Pro: 1 – not included; 2 – included

PC ACCESSORIES

UL-0200	Vehicle Adaptor (12 – 32 V) for 7204-A-xx[†]
UL-0253	Dell® 20″ LCD Flat Panel Monitor
UL-0254	Dell® 22″ LCD Flat Panel Monitor
UL-0255	Dell® 24″ Widescreen LCD Flat Panel Monitor

Service Products

ACCREDITED CALIBRATION

3050-CAI	Type 3050 Initial Accredited Calibration
3052-CAI	Type 3052 Initial Accredited Calibration
3053-CAI	Type 3053 Initial Accredited Calibration
3056-CAI	Type 3056 Initial Accredited Calibration
3057-CAI	Type 3057 Initial Accredited Calibration
3160-CAI	Type 3160 Initial Accredited Calibration
3161-CAI	Type 3161 Initial Accredited Calibration

3050-CAF	Type 3050 Accredited Calibration
3052-CAF	Type 3052 Accredited Calibration
3053-CAF	Type 3053 Accredited Calibration
3056-CAF	Type 3056 Accredited Calibration
3057-CAF	Type 3057 Accredited Calibration
3160-CAF	Type 3160 Accredited Calibration
3161-CAF	Type 3161 Accredited Calibration

TRACEABLE CALIBRATION

3050-CTF	Type 3050 Traceable Calibration
3052-CTF	Type 3052 Traceable Calibration
3053-CTF	Type 3053 Traceable Calibration
3056-CTF	Type 3056 Traceable Calibration
3057-CTF	Type 3057 Traceable Calibration
3160-CTF	Type 3160 Traceable Calibration
3161-CTF	Type 3161 Traceable Calibration

CONFORMANCE TEST

3050-TCF	Type 3050 LAN-XI Conformance Test with Certificate
3052-TCF	Type 3052 LAN-XI Conformance Test with Certificate
3053-TCF	Type 3053 LAN-XI Conformance Test with Certificate
3056-TCF	Type 3056 LAN-XI Conformance Test with Certificate
3057-TCF	Type 3057 LAN-XI Conformance Test with Certificate
3160-TCF	Type 3160 LAN-XI Conformance Test with Certificate
3161-TCF	Type 3161 LAN-XI Conformance Test with Certificate

A wide range of Brüel & Kjær accelerometers, microphones, preamplifiers and sound intensity probes is available for use with a LAN-XI system. The system supports IEEE 1451.4-capable transducers with standardized TEDS. Please see www.bksv.com.

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