The PULSE™ Vehicle Pass-by Test system helps you measure operational vehicle exterior noise according to commonly used international standards. Configurations range from simple setups for pass-by testing of two-wheelers to high-productivity multi-vehicle pass-by testing, where runs for several vehicles tested to different standards are performed in random order.

The system is based on the LAN-XI data acquisition platform, with built-in GPS for data synchronization across ground and vehicle stations during the test. Depending on your configuration, measurement data from both stations can be wirelessly merged after each test run. This robust system architecture ensures high-quality test results, even under difficult wireless transmission conditions.

The system is scalable, ranging from conformance test configurations to multi-vehicle configurations with on-board vehicle measurement channels. Single-person operation is also supported.

Uses and Features

Uses
- Pass-by noise testing of accelerating road vehicles according to a variety of international standards, such as ISO 362:1998 and ISO 362 – 1:2012 for Type M (light vehicles) and Type N (trucks) category vehicles; and ISO 362 – 2:2012 for Type L category vehicles (two-wheelers)
- Measurement of operational vehicle exterior noise according to standards such as ISO 3325 (tyres) and ISO 5130 (exhaust noise)
- Conformance to ISO test procedure-based regulations such as UN/ECE R51.03 (noise emission of M and N category vehicles), UN/ECE R41.04 (noise emission of L category (motorcycles) and UN/ECE R117 (tyre noise)

Features
- System for pass-by measurements including exterior noise measurements such as tyre and exhaust noise
- Telemetry-based systems for 2-wheelers
- Multi-vehicle setup for testing several vehicles on the track
- Measurement controls in vehicle to guide the driver during test
- Single-person operation
- Scalable solution
- On-vehicle sound and vibration measurement channels
- User-definable calculations of final result to adapt to different standards and regulations
- Data-centric solution for organizing all aspects of the measurement
- Export of results in common data formats
- Easy configuration of customised procedures including modifications to international standards
- Advanced reporting to Microsoft® Word and Excel®
- Storing of raw time data, including metadata for post-processing
Why Do Pass-by Measurements?

Pass-by measurements are mandatory for automotive manufacturers for product certification. For certification in a specific market or class, manufacturers must comply with the standards and regulations in that region and/or for that specific class of vehicle.

Pass-by measurements are also used as a product development and troubleshooting tool. For component suppliers and vehicle manufacturers, in particular, it is crucial to identify the contribution of noise sources. Testers can compare spectra and levels from in-vehicle measurements with microphone signals at the ISO-designated positions on the ground. The idea is to identify which components may be main contributors at any given test track position or frequency. For more detailed noise source contribution investigations, Brüel & Kjær offers Moving Source Beamforming and Indoor Pass-by/Contribution Analysis. Brüel & Kjaer’s Exterior Sound Simulator allows subjective evaluation of exterior noise.

The PULSE Pass-by Measurement Solution

The PULSE vehicle pass-by solutions are complete PULSE multi-analyzer-based systems that include LAN-XI data acquisition hardware.

The complete system includes pass-by related accessories such as:
- Photocells for giving absolute position reference
- A speed sensor (radar, GPS or other device) for providing continuous speed and position information
- A weather station for providing environmental parameters.

Depending on the test scenario, a system may consist of a ground station and one or more vehicle stations.

For testing of two-wheelers or other vehicles where only engine RPM or GPS-based vehicle speed are required from the vehicle, the ground station will control the test and receive the data from the vehicle via radio telemetry.

When more data, such as noise data, are measured in the vehicle during testing or when multiple vehicles are being tested simultaneously, the system configuration consists of a ground station and one vehicle station for each vehicle on the track. In this configuration, data between the ground and vehicle stations are synchronized via GPS and merged by the vehicle station via WLAN and automatically processed on the completion of each run. This approach ensures robust operation, even under adverse WLAN communication conditions.

Fig. 1 Overview of a PULSE Vehicle Pass-by system (multi-vehicle setup)
The Ground Station
The ground station measures exterior pass-by noise using two microphones placed at ISO-designated positions on both sides of the test track. Vehicle speed, absolute position reference, and meteorological conditions are measured as well. Once started, the ground station works continuously, unattended.

The Vehicle Station
The vehicle station measures in-vehicle data such as engine RPM, noises and vibrations, and other optional parameters like vehicle speed (if GPS is used). The vehicle station is only needed when a number of in-vehicle parameters and/or multi-vehicle configuration are required.

Communication Between Ground and Vehicle Stations
The ground station records the triggering signal, the acoustic channels, environmental data and the vehicle speed signal, if present. In order for the pass-by data to be synchronized and merged with the in-vehicle data, both stations time stamp the data. Time-stamped data is obtained from GPS satellites. The ground station transfers the data to the vehicle station at the completion of a run. The GPS synchronization is very accurate providing sample-synchronous data between the ground and vehicle stations. The vehicle station merges the data, which are aligned with the time stamp, and calculates the pass-by result.

Measurement Control
The Measurement Control provides an optimized control interface with large buttons for easy in-vehicle operation. The interface displays ambient SPL, weather station parameters and vehicle and engine speed information during the test and switches to show a summary of the run results directly after the test. It supports targets for vehicle and engine speeds that can be set manually or automatically by the system.

![Fig. 2](image-url)

Examples of the Measurement Control’s Drivers Aid interface

Typical System Operation: Multi-vehicle Configuration, Single-user Control

**Pretest**
As part of its full support of the ISO 362 – 1:2012 standard, the Vehicle Pass-by software includes a pretest function for selecting the correct entry speed and correct gear(s) for testing.

![Fig. 3](image-url)

A vehicle approaching the pass-by test zone

With the vehicle far enough away from the test zone so that it does not influence the measurement, the driver presses a button to initiate the acquisition of background noise and meteorological data at the ground station. This data is then sent to the vehicle station via a WLAN connection.
Once the driver initiates the test, all sound and vibration time data, and meteorological, speed, RPM and throttle position data are recorded along with trigger information and GPS time stamps.

The vehicle station requests data from the ground station. A unique ID ensures that only the right data are requested. Data from both stations are synchronized and merged via the WLAN connection. Subsequently, the pass-by measurement results are calculated, displayed and stored on the vehicle station providing immediate validation to the driver.

Multi-vehicle, Multi-driver Test Scenario

Multiple vehicle stations can exist and be operational at the same time on the same course using the same single ground station. Each vehicle can then be measured based on different standards or regulations, regardless of the other vehicles’ measuring schemes.
Compliance with Standards

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

5-MODULE LAN-XI FRONT-END FRAME TYPE 3660-C-100, INPUT MODULE TYPE 3050, PASS-BY CONNECTION MODULE WB-3595 AND BATTERY MODULE TYPE 2831-A

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/IEC 61000–6–1: 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 fulfill 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
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
IEC 60068–2–29: Bump: 3660-C-100: 1000 bumps at: 25 g empty, 15 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: IP 20; 3050, WB-3595 and 2831-A: IP 31

Specifications – Pass-by Ground Station Hardware

The standard Pass-by Ground Station consists of:
• LAN-XI Frame Type 3660-C-100 with GPS
• LAN-XI 6-ch. Input Module Type 3050-A-060
• LAN-XI Battery Module Type 2831-A
• Pass-by Connection Module WB-3595

All modules are mounted in the frame

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
Starts with 19 W if equipped with one LAN-XI module; rises to 70 W if equipped with five LAN-XI modules
Maximum Power Consumption: 90 W

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

BATTERY CHARGING TIME
Mains: 3 hours in frame powered from mains
External DC: No charging

LAN
Frames communicate at 1000 Mbits/s
Connectors: 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). PoE power can be selected on either the first or the second connector
Recommended Cable: Shielded cables of type CAT5e or better should be used. All LAN connectors support MDIX, which means that cables may be crossed or not

PROTOCOL
The following standard protocols are used:
• TCP
• UDP
• DHCP (incl. Auto-IP)
• DNS (on top of UDP)
• 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)

GPS

GPS Antenna (non-magnetic) ZZ-0260 included to allow the use of the time provided by a GPS satellite. GPS time is used:
• To define the absolute time that follows the acquired data
• As an accurate time base that locks the PTP clock on both the master frame and any slaves. Continuous tracking with GPS time allows the acquisition of very long time signals with very high time precision

Connector: SMA
Cable Length: 5 m (16.4 ft)

Input Module
Number of Channels: 6 input
Connectors: BNC
Input Type: Direct, CCLD transducer, microphone preamplifier (0 or 200 V polarization voltage) or charge*
Frequency Range: 0 to 51.2 kHz
Input Voltage: Up to 10 V_peak; extended range up to 31.6 V_peak
Absolute Maximum Input: 60 V_peak without damage

See LAN-XI product data, BP 2215, for full specifications

Pass-by Connection Module WB-3595

PHOTOCELL CONNECTION
Input Channels: 2 × 6-pole LEMO female, 12 V power, max. current 2.5 A
Output Channel: BNC

* Via CCLD Converter Type 2646 or the range of Charge to CCLD Converters Type 2647

Specifications – Pass-by Vehicle Station Hardware

The standard Pass-by Vehicle Station consists of:
• LAN-XI Frame Type 3660-C-100 with GPS
• LAN-XI 6-ch. Input Module Type 3050-A-060
• LAN-XI Battery Module Type 2831-A
• Pass-by Connection Module WB-3595
• DC Power Cable AO-1489-D-030 (connects WB-3595 to vehicle cigarette lighter)

All modules are mounted in the frame
Specifications are the same as the Ground Station

Specifications – PULSE Vehicle Pass-by Software Types 7788-G/V

Vehicle Pass-by Software Types 7788-G/V works with the Pass-by hardware listed above. Licenses for this system are node-locked

System Requirements
• PULSE Single Module Front-end Driver Type 3099-A-N1 (node-locked)
• High-performance PC running Windows® 7 or higher

Recommended PC
• Intel® Core™ i7 3 GHz processor, or better
• 16 GB RAM
• 480 GB Solid State Drive (SSD) with 20 GB free space, or better
• DVD-RW drive

• 1 Gbit Ethernet network
• Microsoft® Windows® 8.1 Pro or Enterprise (x64), Windows® 7 Pro, Enterprise or Ultimate (x64)
• Microsoft® Office 2013
• Adobe® Reader® 11 (US version available on PULSE installation DVD)
• Microsoft® SQL Server® 2012 Express (SP 2) (included with PULSE)

Measurement
Vehicle speed and position measured relative to a reference (photocell), noise measured via two microphones (left and right) and additional parameters
PULSE PASS-BY GROUND SYSTEM TYPE 7788-G

Ground Channels:
- Vehicle speed using radar
- Noise: Overall, FFT, and CPB slices as functions of distance, speed or time, CPB and FFT contours as functions of speed and time
- Auxiliary Parameters: Air temperature, relative humidity, wind speed, wind direction and user-defined parameters, instantaneous, averaged and max. values available as tags on waterfall data (up to 12 channels)

PULSE PASS-BY VEHICLE SYSTEM TYPE 7788-V

Ground and In-vehicle Channels: Same as Type 7788-G with the addition of:
- Vehicle engine speed, vehicle throttle position, user-definable (dependent on hardware and software license) order analysis with doppler correction
- Auxiliary Parameters: In-car, user-definable, 12 channels

Calibration
Calibration of dynamic channels using the PULSE Calibration Master. Calibration histories available from the Global Calibration Database

User Interface
- Standard Windows®-based GUI
- Four-button operation (Activate, Run, Accept and Cancel)

Specifications – Other Pass-by Hardware

Ground Parameters
PREPOLARIZED MICROPHONE WITH PREAMPLIFIER TYPE 4189-A-021
Measures sound pressure level. Two microphones required
- Sensitivity: 50 mV/Pa
- Frequency: 6.3 Hz – 20 kHz
- Dynamic Range: 14.6 – 146 dB
- Temperature: –30 to +150 °C (–22 to +302 °F)

PHOTOCELL BUNDLE WU-0584-T39
Photocell and reflector set to provide triggering and an absolute position reference used for distance calculations. Use one set for single-direction measurements; two sets for bidirectional measurements

ON-VEHICLE PHOTOCELL WB-3458 (optional)
Photocell mounted on vehicle to provide triggering and an absolute position reference, relieving the driver of the task of starting the measurement for each run

WEATHER STATION MM-0256-W-002 (optional)
Measures wind speed, wind direction, temperature, humidity and atmospheric pressure. Includes PoE box for connection to LAN-XI frame and provides power to weather station

GROUND TEMPERATURE SENSOR UNIT WQ-2809 (optional)
Measures asphalt temperature. Powered by a mains supply with own conditioning unit. The output is an analog voltage that is measured by an input channel on the front end

In-vehicle Parameters
GPS SPEED SENSOR WQ-3207 (optional)
100 Hz speed sensor. Measures in-vehicle speed alone with the ground station (via radio telemetry) or in a multi-vehicle configuration

Other devices capable of providing TTL pulses between 1 – 12 V frequency modulated according to speed may also be used

THROTTLE POSITION SENSOR MM-0097 (optional)
Pressure sensitive on/off sensor that measures the throttle position

Data Transfer and Interfaces
2-CH. RADIO TELEMETRY WQ-3208 (optional)
When engine RPM and speed measurements are necessary. Includes both a receiver that connects to the ground station’s input module, and a transmitter to which the in-vehicle sensors connect directly

WLAN
WLAN Telemetry Kit. For systems where there is a need for vehicle parameters such as engine RPM, throttle position or vehicle speed from an onboard precision GPS sensor

Ordering Information
Type 7788-G-N PULSE Vehicle Pass-by System, Ground Station (node-locked)
Type 7788-V-N PULSE Vehicle Pass-by System, Vehicle Station (node-locked)
Type 3099-A-N1 PULSE Single Module Front-end Driver (node-locked)

Type 7788-G-N supports Pass-by testing, with up to two channel telemetry from the vehicle
Types 7788-G-N and 7788-V-N are needed when sound and/or vibration is measured in the vehicle (single vehicle or multi-vehicle)
Pass-by Hardware and Accessories

GROUND STATION
The PULSE Vehicle Pass-by Ground Station includes:
• LAN-XI Frame Type 3660-C-100 with GPS Antenna ZH-0260
• LAN-XI 6-ch. Input Module Type 3050-A-060
• LAN-XI Battery Module Type 2831-A
• Pass-by Connection Module WB-3595
All modules are mounted in the frame
Contact your local sales representative for more information

VEHICLE STATION
The PULSE Vehicle Pass-by Vehicle Station includes:
• LAN-XI Frame Type 3660-C-100 with GPS Antenna ZH-0260
• LAN-XI 6-ch. Input Module Type 3050-A-060
• LAN-XI Battery Module Type 2831-A
• Pass-by Connection Module WB-3595
• DC Power Cable, XLR to car plug AO-1489-D-030 (connects WB-3595 to vehicle cigarette lighter)
All modules are mounted in the frame
Contact your local sales representative for more information

PC FOR RUNNING SOFTWARE
Type 7201-F-xx2* Dell® Latitude® High-end Notebook with Microsoft® Office Professional (no manuals)

MEASURING GROUND PARAMETERS
2 × Type 4189-A-021 Prepolarized Microphone
AO-0426-D-xxx† Double-screened Coaxial Cable, BNC to BNC connector
2 × UA-0237 Windscreen
2 × UA-0588 Microphone Holder
WU-0584–T39‡ Photocell Bundle, incl. photocell, reflector, tripods and cable roller
2 × UA-0801** Lightweight Tripod, for microphones

MEASURING IN-VEHICLE PARAMETERS
WQ-3582 LAN-XI Frame Securing Fixture
WQ-2410 Power Splitter (1 to 2) for Cigarette Lighter Socket

Optional Accessories

AUTO-TRIGGERING
WB-3458 On-vehicle Photocell Unit, incl. photocell and reflector

MEASURING VEHICLE SPEED
Type 2982 Radar Unit
UA-1522 Tripod, for radar unit

WQ-1185 Cable Drum Extension, for radar unit
WQ-3207 100 Hz GPS Speed Sensor

MEASURING ENVIRONMENTAL CONDITIONS
MM-0256-W-002 Digital Weather Station, incl. PoE box, tripod and cable
WQ-2809 Ground Temperature Sensor Unit, incl. conditioning unit

MEASURING THROTTLE POSITION
MM-0097 Throttle Position Sensor

MEASURING TACHO
WQ-2350 Cigarette Lighter Tacho Sensor
WQ-3568 Hand-held Digital Tachometer (for use on two-wheeled vehicles)

MEASURING 2 CHANNELS OF IN-VEHICLE PARAMETERS ONLY
WQ-3208 2-ch. Telemetry, 3.2 kHz
WQ-2410 Power Splitter (1 to 2) for Cigarette Lighter Socket

MULTI-VEHICLE CONFIGURATION (SINGLE PERSON OPERATION)
FOR EACH VEHICLE:
WQ-3528 WLAN Wireless Radio
WQ-3561 WLAN Antenna

FOR THE GROUND STATION:
WQ-3530 WLAN Base Station
WQ-3529 WLAN Antenna

CABLE ACCESSORIES
AO-0479-D-xxx† BNC to LEMO Adapter Cable
WL-1391-D-xxx† Cable Drum with double-screened BNC cable, for microphones

Service and Support

MAINTENANCE AND SUPPORT AGREEMENTS
M1-7788-G-N Software Maintenance and Support Agreement for Type 7788-G-N
M1-7788-V-N Software Maintenance and Support Agreement for Type 7788-V-N
M1-3099-A-N1 Software Maintenance and Support Agreement for Type 3099-A-N1

CALIBRATION
BK-0115 Accredited Calibration as SLM (IEC 60651) for PULSE Front-end, 1 channel
BK-0115-001 Accredited Calibration as SLM (IEC 60651) for PULSE Front-end, Additional channels

INSTALLATION AND TRAINING
BK-0058 System Installation, per day
BK-0060 On-site Training, per day

* xx specifies country: GB, DE, FR, ES, IT, SE
† Where D is decimetres and xxx is the length
‡ Need two to support bidirectional measurements
** Need four to support bidirectional measurements

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