

SYSTEM SUMMARY

Static Engine Certification Test (SECT) System

The Brüel & Kjær Static Engine Certification Test (SECT) System accurately performs all the tasks needed for static engine noise certification and development testing, and is based on Brüel & Kjær's standard, commercial-off-the-shelf (COTS) products that cover the entire measurement chain.

As static aircraft engine noise ground tests are usually less costly than flight tests and are less affected by atmospheric conditions, ground surface variations, flight paths, etc., they are, therefore more predictable. Static aircraft engine noise ground tests are performed to define the engine ground static noise measurements. This means that after the initial aircraft noise certification, aircraft manufacturers do not need to do a full noise certification test on new engines, or engines that have been modified. They can get the new (or modified) engines noise certified by the authorities via the Ground to Flight Equivalence (GTFE) procedure.



All the necessary tasks, including correction to reference day conditions using the SECT PULSE application software, are incorporated within the SECT System, providing you with a complete workflow-driven solution supporting all the phases of the noise certification process. As Brüel & Kjær's SECT System is an open framework, additional research and development tasks (based upon individual customer requirements) can be added or incorporated within the workflow of the system.

For further information on Brüel & Kjær's Aerospace solutions, see our web page at bksv.com.

Adhering to Standards

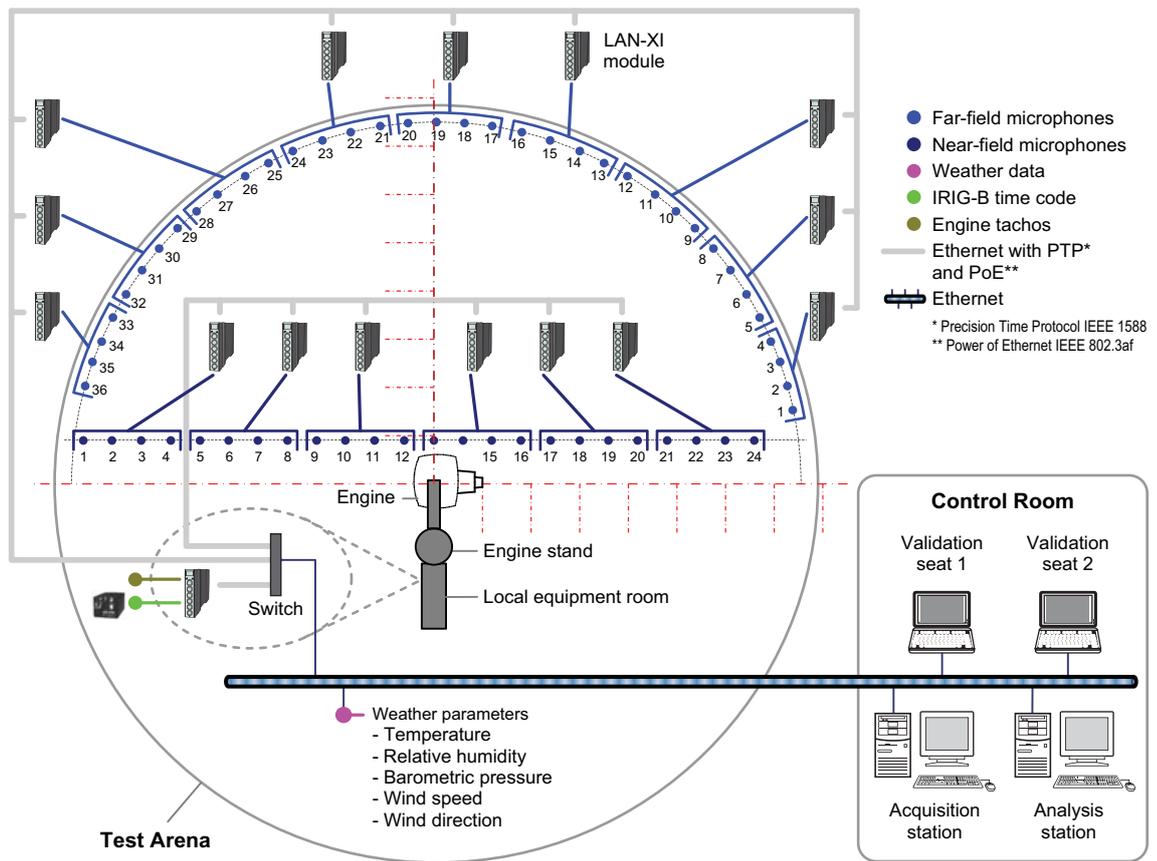
In order to generate the full set of data to support engine and airframe manufacturers with Ground to Flight Equivalence procedures, the Brüel & Kjær SECT System follows the measurement requirements and procedures set forth by the industry noise certification standards FAR 36 and ICAO Annex 16, SAE ARP 1846 A and the ARP 866A – Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity.^{1,2,3}

The SECT System employs Brüel & Kjær's PULSE data acquisition and analysis (overall and 1/3rd-octave) system. It acquires all the relevant noise and weather data needed to generate certificated noise levels, and corrects this data to standard reference conditions, for both measurement equipment, and for atmospheric absorption.³

SECT System Description

The SECT system is a dedicated application integrating and optimising the different inherent features of Brüel & Kjær's COTS products, which encompass the whole measurement chain and provide you with a dedicated streamlined workflow to ensure that all required tasks and operations are performed with maximum reliability and efficiency. A schematic is provided in Fig. 1.

Fig. 1
 Schematic overview of SECT System. Far-field and near-field microphones are arranged in predetermined positions with respect to the test engine. Using the inherent features of PULSE LAN-XI, PTP and PoE, the different LAN-XI modules are distributed on the test arena close to the microphones, which significantly limits analog cabling costs. (PTP – Precision Time Protocol, IEEE standard 1588; PoE – Power over Ethernet, IEEE standard 802.3af)



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SECT System Components

The SECT System consists of:

- The necessary number of microphones, preamplifiers, and cables for far-field and near-field microphone signals:
 - 1/2" Pressure-field Microphones Type 4192, 200 V Polarization (Falcon range)⁵
 - Preamplifiers Type 2669-W-004 with TEDS, CIC and VIC capabilities⁶

Note: The combination of the SECT System and the dedicated preamplifier provide the Transducer Electronic data Sheet (TEDS), Voltage Injection Check (VIC) and Charge Injection Check (CIC) functionality to maximise the overall system reliability and efficiency. For more details, see 'Calibration' under 'SECT PULSE Application Software' below

- Cables at desired lengths
- An Acquisition Station installed with:
 - PULSE Type 7700: Base PULSE LabShop software for FFT, CPB (1/n-octave) and Overall Analysis
 - PULSE Data Manager Type 7767: PULSE Data Manager enables measurement data to be labelled with meta-data and saved to a database
 - SECT PULSE Application Software: A dedicated application specifically for static engine certification. See the following section for an overview of the tasks included with the application
 - Headphones: To listen to selected signals
 - An IRIG-B Receiver: For time-stamping and time correlation of the acquired acoustic data with other datasets
 - A Weather Station: To acquire all of the necessary temperature, wind speed, wind direction, barometric pressure, and relative humidity data
 - Interface to other 3rd party data (if required)
- Multiple LAN-XI Measurement Modules, with ruggedized outdoor enclosures situated on the Test Arena:
 - Generator Type 3160-A-042, 4/2-ch input/output

Note: LAN-XI modules are equipped with a generator, which in combination with the embedded CIC functionality within the SECT System and dedicated preamplifier, allow you to perform a quick total system check (i.e., within a few seconds)

- A Dedicated LAN-XI Module: Located in the equipment room (test stand) to acquire engine tacho signals
- Network Connection: All the LAN-XI modules are connected to the Acquisition Station via a dedicated network, for:
 - data acquisition
 - time synchronisation, via the Precision Time Protocol (IEEE standard 1588)
 - powering of all the LAN-XI units via Power over Ethernet (IEEE standard 802.3af)

In addition:

- Additional Validation Seats can be added to the SECT System (see Fig. 1). A validation seat is a basic Windows-based[®] laptop installed with dedicated Brüel & Kjær Validation Application software, allowing other users to visualise in real-time the acquired data

SECT PULSE Application Software

The SECT PULSE application software installed on acquisition station PCs, is a dedicated Data Acquisition and Handling (DAQ-H) framework application, incorporating all the required features and functions to support the Engine Noise Certification process in accordance with industry standards.^{1,2,3,4} Throughout the process of correcting data for reference day conditions, both corrected and uncorrected data is stored in the underlying PULSE Data Manager database. This is to ensure that applied corrections can always be rolled-back or repeated using the initial raw and uncorrected data. Furthermore, at relevant points within the process, appropriate meta-data (defined by you and incorporated within the workflow) are available to document the test during its different stages.

The SECT PULSE application software supports a workflow based on individual customer requirements, and includes the following functionality required for engine noise certification applications:

System Set-up

The system set-up functionality uses TEDS (Transducer Electronic Data Sheets) to acquire the relevant information from the transducers of all connected microphones. This includes: sensitivity; serial number; manufacturer and calibration date. Furthermore, the system Set-up task manages all the different correction curves (microphone calibration data, microphone grid, windscreens, etc.), which are used to correct the acquired acoustic test data to reference day conditions in a later phase of the overall process.

Calibration

In line with the relevant industry standard, the SECT System performs a full system calibration pre- and post-test, using an acoustic calibrator or pistonphone. It uses the Voltage Insert Calibration (VIC) functionality to obtain 'line inserts' and to verify the electrical sensitivity of the complete acoustic channel. The VIC functionality measures the frequency response of the entire measurement system using pink noise. By employing an adaptor cable and using the microphone capsule as a capacitive coupler, this Brüel & Kjær method allows you to insert pink noise without disassembling the microphone capsule. This avoids having to break the calibration seal of the preamplifier and microphone combination and prevents possible field contamination of the cavity between the microphone and preamplifier.

Brüel & Kjær's patented Charge Injection Check (CIC) function can be performed regularly throughout the measurement day for rapid system validation of the complete system. The CIC function, contrary to VIC, also includes the microphone cartridge and, thereby, provides a validation of the complete acoustic chain, including the microphone. At a later stage, the data acquired during the calibration task is used to correct for the measurement system and to obtain reference day conditions.

Recording and Validation

Ambient noise measurements are performed before and after the test. This data is also used at a later stage to correct the acquired acoustic test data to reference day conditions. During the actual recording, all test data is acquired and analysed in real-time and the analysed data is provided through the SECT PULSE application to different validation seats, equipped with the Validation Application software. During recording, a set of acoustic channels can be listened to via headphones.

Post-processing

Immediately after the test is completed, post-processing, in the form of data correction, i.e., applying the measurement system, background noise and atmospheric absorption corrections, is performed.⁴ In accordance with customer requirements, the SECT System can provide for extensive automated report generation, and data archiving. Data export to different Microsoft[®] Excel[®] spreadsheets is included.

The Validation Application

With the Validation Application software installed on a basic Windows[®]-based laptop, you can 'subscribe' to the SECT PULSE application software installed on the acquisition station to acquire the analysed data.

Validation Application software provides the following functionality:

- Selection of multiple channels
- Visualisation of data on selected channels (time, FFT or CPB)
- Time history on all channels
- Level meter for all channels

Using the real-time capability of the PULSE software, multiple validation seats can be added to the SECT System, allowing different engineers to validate acquired data.

References

1. Federal Aviation Administration, Department of Transportation, Subchapter C – Aircraft, PART 36. Noise Standards: Aircraft Type and Airworthiness Certification
2. ICAO Annex16, Environmental Protection, Volume I, Aircraft Noise
3. ARP 866 A – Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity
4. ICAO DOC 9501 – Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft
5. BP 1380, Product Data for Falcon Range ½" Microphones, Brüel & Kjær
6. BP 1422, Product Data for Preamplifier Type 2669 supporting TEDS and CIC and VIC Calibrations, Brüel & Kjær

Other references:

- BN 0856, INTA – Case Study for Exterior Noise certification of Airbus A330 MRTT, Brüel & Kjær
- "NPO Saturn – How to Certify Aero Engines", Brüel & Kjær Waves Magazine, Issue 2, 2010
- BU 0229, System Data for PULSE Software, Brüel & Kjær
- BP 2215, Product Data for LAN-XI Data Acquisition Hardware Type 3660-D for PULSE and Test for I-deas, Brüel & Kjær
- BG 1695, Brochure, "Less is More LAN-XI", Brüel & Kjær

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