SYSTEM SUMMARY

Aircraft Noise Certification Test System

The Brüel & Kjær Aircraft Noise Certification Test (ANCT) System accurately performs all tasks needed for aircraft noise certification testing, and is based on Brüel & Kjær's standard, commercial-off-the-shelf (COTS) products that cover the entire measurement chain.

Aircraft noise certification tests are required in order to establish certified aircraft Effective Perceived Noise Levels (EPNL) at each of the Approach, Flyover and Sideline certification flight conditions – in accordance with relevant aircraft noise certification standards ICAO Annex 16 and/or FAR 36 and IEC 61265.

Brüel & Kjær's PULSE™ hardware and software solutions have been approved for use by aircraft manufacturers in aircraft noise certification according to international standards. With this PULSE-based system, all the necessary tasks, including corrections to reference day conditions using the ANCT PULSE application software, are incorporated, providing you with a complete workflow-driven solution supporting all the phases of the noise certification process. As Brüel & Kjær's ANCT software is an open framework, additional research and development tasks (based on individual requirements) can also 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 certified flight Effective Perceived Noise Levels (EPNL), the ANCT System follows the measurement requirements and procedures set forth by the industry noise certification standards: FAR 36 and ICAO Annex 16 and IEC 61265 – Instruments for Measurement of Aircraft Noise.[1,2,3]

The ANCT System employs the Brüel & Kjær PULSE data acquisition and analysis (overall and 1/3-octave) system and supports Intercept and Break-Off flight track test procedures, as outlined in "Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft".[4] This procedure is widely accepted by the aircraft noise certification community as the most efficient, as it eliminates the need for actual take-offs and landings, thereby providing significant operational advantages and substantially reducing flight testing time and costs.

The ANCT software performs corrections to reference day conditions for:
- Measurement equipment
- Background noise
- Weather conditions
- Aircraft position
- Location of maximum lateral sideline noise level, PNLM (Perceived Noise Level Maximum)

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Adhering to Standards (Cont'd.)

The measured data are adjusted to reference conditions using the 'integrated' adjustment procedure, as defined in FAR Part 36/ICAO Annex 16. For each measurement channel, the system uses the acquired aircraft flight track and layered weather data to calculate:
- EPNL (Effective Perceived Noise Level)
- $PNLT_{max}$ (maximum tone corrected PNL)
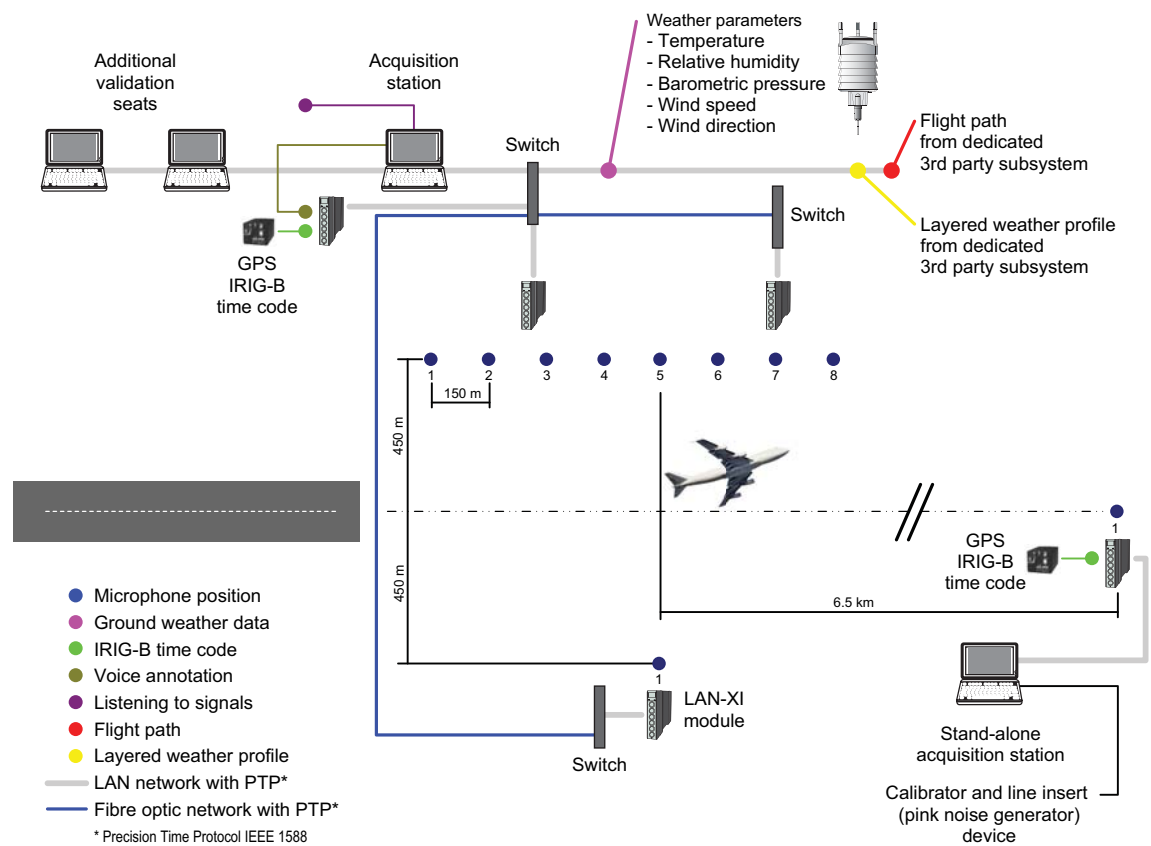- 10 dB down-points (start and end of the PNLT time integration period)

To validate measurements during testing, the ANCT System also calculates EPNL dB levels.

ANCT System Description

The ANCT System is a dedicated solution integrating and optimising the different inherent features of the Brüel & Kjær's COTS products. These products 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 Brüel & Kjær's ANCT System.
The layout shown has a sideline array, which allows for obtaining the $EPNL_{max}$ in a single flight, as the system has multiple microphones. An alternative to this setup is to use the minimum number of microphones (×3), and do multiple flights to establish the correct measurement point at $EPNL_{max}$.
Based upon user preference/require-ments, the ANCT System supports different measurement system layouts

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ANCT System Components

The ANCT System consists of:
- The necessary number of microphones, preamplifiers, and cables to support the desired noise measurements:
  – 1/2″ Pressure-field Microphones Type 4192, 200 V Polarization (Falcon range)[5]
  – Preamplifiers Type 2669-W-004 with TEDS, CIC and VIC capabilities[6]

  Note: The combination of the ANCT 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 'ANCT PULSE Application Software' below

  – Cables at desired lengths

- An Acquisition Station installed with:
  - PULSE Type 7700: Base 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
  - ANCT PULSE Application Software: A dedicated application specifically for aircraft 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 data sets such as actual flight path and layered weather profile
  - Interface to 3rd party data such as layered weather data and aircraft flight profile in order to correct reference day conditions
- Multiple LAN-XI Measurement Modules, with ruggedized outdoor enclosures:
  - 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 ANCT System and dedicated preamplifier, allow you to perform a quick total system check (i.e., within a few seconds)

In addition:

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

- An additional stand-alone acquisition station, with its own IRIG-B receiver can also be added to the ANCT System. At a later stage, the acquired data can be combined with the data acquired from the acquisition station into a single dataset

ANCT PULSE Application Software

The ANCT 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 Aircraft 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 ensures 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 the customer and incorporated within the workflow) are available to document the test during its different stages.

The ANCT PULSE application software supports a workflow based on individual customer requirements, and includes the following functionality, which is required for aircraft 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 flight test data to reference day conditions in a later phase of the overall process.

Calibration
In line with ICAO Annex 16 and FAR 36, the ANCT 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 flight test data to reference day conditions.

During the actual recording, all flight test data is acquired and analysed in real-time and the analysed data is provided through the ANCT PULSE application software to different validation seats, equipped with Validation Application software. During recording, a set of acoustic channels can be listened to via the headphones. Immediately after the flyover, an initial estimation of EPNL, $PNLT_{max}$, and the 10 dB down-points is provided by the ANCT System, based on the previously acquired weather profile and planned, instead of actual flight track data.

Post-processing

In accordance with FAR 36, or ICAO Annex 16, the measurement data are corrected to reference day conditions. This includes corrections for: the measurement system, background noise, the weather profile during flight and the actual flight path. In addition, for each individual channel, the EPNL, $PNLT_{max}$ and the 10 dB down-points parameters are determined.

In accordance with the customer's requirements, the ANCT System can provide for extensive automated report generation and data archiving. Data export to different Microsoft® Excel® spreadsheets are included.

The Validation Application

With the Validation Application software installed on a basic Windows®-based laptop, you can 'subscribe' to the Aircraft Noise Certification Test (ANCT) PULSE application software installed on the acquisition station to acquire the analysed data.

The Validation Application 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 ANCT 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. IEC 61265 – Electroacoustics – Instruments for Measurement of Aircraft Noise – Performance Requirements for Systems to Measure One-third Octave Band Sound Pressure Levels in Noise Certification of Transport-Category Aeroplanes
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:
- ARP 866 A – Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity
- BN 0856, INTA – Case Study for Exterior Noise Certification of Airbus A330 MRTT, Brüel & Kjær
- 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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