Aircraft Noise Monitoring System

Ever since introducing the sound level meter N-1101 in 1956, RION Corporation has been active as a leader in the field of noise measurement research and in the development and marketing of high-quality sound level measuring equipment.

For over 40 years, we also have been engaged in developing, manufacturing and marketing products designed for environmental noise monitoring. Ensuring a safe and comfortable living environment for all members of society is more important than ever. We are now offering a state-of-the-art aircraft noise monitoring system that fully reflects our extensive experience and technological know-how in this field.

The RION advantage

- Support for long-term, unattended monitoring periods is built into the system as a matter of course. The MS-11A microphone incorporates an automatic sensitivity checking function that checks daily for continued accuracy.
- Aircraft noise identification by sound is possible with two integrated methods: sound arrival direction identification and noise event clustering identification using frequency analysis.
- Highly efficient energy saving design, compact dimensions, and low weight.
All required functions for aircraft noise measurement combined in a single system

Improved aircraft identification supports long-term measurement and generates more accurate data. Compact and lightweight design facilitates installation. Power consumption reduced by about fifty percent.

Aircraft Noise Monitoring System

This system is designed for automated monitoring of aircraft noise. It is capable of calculating evaluation values according to the "Environmental Standard Related to Aircraft Noise". The sound source identification provided as a standard feature is based on real time 1/3 octave band analysis. A GPS function is also standard, for obtaining location information and enabling automatic time calibration.

- Various noise level data along with time and location information from the GPS are saved on SD card.
- Noise arrival direction information and aircraft transponder data are recorded simultaneously with noise event data. (Using optional Noise Arrival Direction Identification Unit AN-39D and SSR Receiver Unit AN-39R)
- Real sound recording program NX-39WR (option) allows sound recording in two format types:
  - Compressed (for long-term recording)
  - PCM (for analysis)
- LAN port and modem connector enable Internet connection via an external router or an ordinary telephone line. Data collection and compilation can be performed automatically, and the data transfer in real time supported.
- Standard compliance
  - Environmental Standard Related to Aircraft Noise (Dec. 17, 2007)
  - ISO 20906 : 2009 (Acoustics -- Unattended monitoring of aircraft sound in the vicinity of airports)
**Product Information**

**Environmental Noise Monitor NA-39A**
Compliant with IEC 61672-1: 2013 class 1 (JIS C 1509-1: 2017 class 1) (Also when dedicated microphone extension cable up to 105 m and all-weather windscreen is used). Standard configuration includes one-third octave frequency analysis function.

**Outdoor Microphone MS-11A**
A microphone is a very delicate and precise device which means that there is a possibility of temporary or permanent change in sensitivity during prolonged outdoor use. The Outdoor Microphone MS-11A therefore incorporates an anti-condensation heater that counteracts the main cause of sensitivity drift. An internal sound source for testing is also provided, enabling daily automatic sensitivity checking.

**Noise Arrival Direction Identification Unit AN-39D**
Elevation angle and bearing are measured using four microphones, to identify the arrival direction of aircraft noise and ground-level sound. From the sound source location and movement direction, aircraft noise can be identified with high accuracy.

**All-Weather Windscreen WS-13**
The all-weather windscreen is specially designed for the Outdoor Microphone MS-11A used with the Environmental Noise Monitor NA-39A. The combination of NA-39A and WS-13 ensures that the JIS C 1509-1: 2017 class 1 specifications are met with the windscreen in place. Wind noise at a wind speed of 10 m/s is less than 60 dB (A-weighted), and the bird spikes guard against damage by birds. Furthermore, the WS-13 not only reduces the adverse effects of wind noise, it also provides precipitation protection with an IPX3 rating.

**SSR Receiver Unit AN-39R**
Receives SSR (Secondary Surveillance Radar) information used for air traffic control. Capable of capturing the squawk code (temporary 4-digit identification code), pressure altitude, and address (unique aircraft number). (Only for aircraft transmitting this information)

**Options**

**Carrying Case**
Convenient for mobile measurement.

**Tilt type microphone stand ST-88S**
This collapsible tripod is easy to set up and maintenance-friendly.

**Cubicle example QC-01**
Suitable for outdoor installation. Internal ventilation is a standard feature, and a heater can also be installed as necessary.
Noise Arrival Direction Identification Unit AN-39D

This device determines the arrival direction of sound from a moving sound source by using the correlation method. It is used predominantly for aircraft noise identification in the vicinity of airports.

**Overhead sound identification using the correlation method**

**Principle**

Two microphones are arranged in a perpendicular position as shown in Figure 1, with the distance between the microphones expressed as d.

When the sound from an aircraft arrives with an elevation angle θ, the following equation applies, where τ is the time difference between the arrival time of the sound at the two microphones (M1, M2), and c is the acoustic speed in air.

\[ \tau = \frac{d}{c} \times \sin (\theta) \]

When the sound arrival direction is sufficiently steep (θ > 0), the elevation angle information can be used for the identification of aircraft sound.

When a sound event is detected, track of elevation angle is also recorded, and events which fulfill certain specified conditions (angle threshold and angle ratio) are considered as aircraft noises.

**Detection of sound arrival direction in 3-axis.**

As shown in Figure 2, four microphones are arranged on three orthogonal axes. This allows calculation of sound arrival direction vectors (elevation angle, azimuth angle) which can be used to identify the direction of the sound source more precisely.

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SSR Receiver Unit AN-39R

This device receives the response signal of the aircraft to the secondary radar (SSR: Secondary Surveillance Radar) of the air traffic control system to detect the proximity of aircraft.

**Identification of aircraft sound using Radar signal method (AN-39R only)**

Air traffic control systems constantly send radar inquiry signals to aircraft to which aircraft reply with an identification code and other information including pressure altitude data. The AN-39R can receive such response signals.

The distance of approach of an aircraft is detected by receiving the intensity of a radar signal level. By comparing the signal to a certain threshold as synchronized to a sound event, identification of the sound event as aircraft is possible.

By using a combination of acoustic and radar signal detection, information of the identification can be increased, especially in acoustically complex locations where the aircraft may be intermittently blocked from other sound.
Example for overhead sound identification

Processes the sound arrival direction data using window function calculation to determine flight noise events, ground-level sound events and other sound events (for exclusion).

Aircraft noise event detection method

Single noise

- **Noise level**
  - Maximum noise level
  - Threshold level
  - Background noise level (BGN)
  - 10 dB

- **Event time**
  - Noise event period (duration)

- **Noise event detected**

Long term noise event

- **Noise level (one second)**
  - 10 dB
  - (Optional setting) 10 dB

- **Start**
- **Long term noise period (more than 300 seconds)**
- **End**

Visualization of how ground noise is generated

Description of ground noise

**Types of noise generated by aircraft**

**Single noise event**
This is a temporary noise which occurs sporadically, such as noise caused by air travel that can be observed within the vicinity of the airport. Above-ground noise produced by aircraft is also a form of single noise.

**Long term noise event**
This noise is steadily produced over a long period of time, but the noise level fluctuates greatly. Common examples are engine testing noise and the noise originating from the auxiliary power unit (APU).

**Glossary**

- **Take off noise**
  - This noise occurs from the time the aircraft starts to taxi out from the end of the runway to the time it reaches the middle of the runway and finally takes off.

- **Taxing**
  - Taxiing indicates the ground run of the aircraft as it travels between the tarmac and the runway.

- **Landing noise**
  - This noise occurs as the aircraft descends, touches down on the runway of the airport, and then reverses the thrust direction of the engines to reduce speed as it leaves the runway.

- **Engine testing**
  - This test is performed to check the operation of the aircraft engines.

- **APU**
  - This small engine (Auxiliary Power Unit) is mounted separately from the main aircraft engine. It is the power source used to supply compressed air, hydraulic pressure, and electric power to the aircraft while it is on the tarmac.

- **Touch and go**
  - This refers to increasing engine output and taking off from the ground after approaching, landing, and reducing speed on the runway as a part of an exercise for take-off and landing training.

- **Hovering**
  - This refers to when a helicopter lifts off and remains stationary while in the air.
### Specifications NA-39A

#### Applicable standards

#### Measurement functions
- **RAW data**
  - Time-weighted sound pressure level \( L_p \)
  - Time average sound pressure level \( L_\text{eq} \)
  - Maximum time-weighted sound pressure level \( L_{\text{max}} \)
  - Minimum time-weighted sound pressure level \( L_{\text{min}} \)
  - Peak sound pressure level \( L_p^{\text{peak}} \)
  - Any combination of frequency weighting characteristics A/C/Z and time weighting characteristics F/S/I is possible.

- **LCD data display**
  - Time-weighted sound pressure level \( L_p \)
  - Time average sound pressure level \( L_\text{eq} \)
  - Maximum time-weighted sound pressure level \( L_{\text{max}} \)
  - Peak sound pressure level \( L_p^{\text{peak}} \)

- **1/3 octave band data**
  - Time-weighted sound pressure level \( L_p \)

- **Real sound data**
  - Option (NX-39WR)

- **Measurement data**
  - \( L_p \), \( L_\text{eq} \), \( L_{\text{max}} \), \( L_{\text{min}} \), \( L_{\text{peak}} \)

#### Microphone and preamplifier
- **Microphone**
  - Outdoor Microphone MS-11A

- **Frequency weighting**
  - A-weighted
  - C-weighted
  - Z-weighted

- **Residual noise level**
  - A-weighted
  - C-weighted
  - Z-weighted

- **Frequency range**
  - 10 Hz to 20 kHz

- **Time weighting characteristics**
  - F (Fast), S (Slow), I (Impulse)

- **Level range switching**
  - No (single range requires no switching)

- **RMS detection circuit**
  - Digital processing method

- **Sampling cycle**
  - 20.8 ms (Sampling frequency 48 kHz)

- **Reference frequency**
  - 1 kHz

- **Reference sound pressure level**
  - 94 dB

- **Correction function**
  - Windscreen correction
  - Diffuse sound field correction function

#### Display and main display contents
- Monochrome LCD with backlight, 64 (H) x 128 (W) dots

- Built-in sound source
  - 250 Hz, 500 Hz, 1 kHz, 4 kHz (for operation checking)

- Alarm indication
  - OVER triggered at 138.3 dB (1 kHz)
  - UNDER triggered at -0.5 dB below measurement lower limit

- Language: English

#### Operation panel
- **Input/output connectors**
  - LAN port
  - Modem connector

- **AC output**
  - Frequency weighting
  - Output voltage
  - Output impedance
  - Load impedance

- **Recording media**
  - SDHC card (standard 8 GB)

- **Data storage**
  - Raw data, measurement data, and messages are saved in a specified format on the recording media.

#### Power requirements
- **AC power source**
  - Input voltage range: 100 to 240 V AC (±10 %)

- **DC power source (12 V)**
  - Output voltage range: 9 to 15 V

- **Power failure backup**
  - Battery: 12 V sealed lead-acid storage battery

#### Power supply frequency
- 50 Hz/60 Hz (±5 %)

#### Dimensions and weight
- **Dimensions**
  - Approx. 200 (H) x 140 (W) x 79 (D) mm (without protruding parts)

- **Weight**
  - Approx. 1.5 kg (excl. microphones and cables)

#### Supplied accessories
- Outdoor microphones, power cord, GPS antenna (with 2 m cable), SDHC card (8 GB)

### Options

#### Name

- Noise Arrival Direction Identification Unit
- SSR Receiver Unit
- Real Sound Recording Software
- Enclosure mounting brackets
- Carrying case (Special cases for various solutions)
- All-weather windscreen
- Tilt type microphone stand
- 7P microphone extension cable
- Identification extension cable
- SSR antenna extension cable
- GPS extension cable

#### Model

- AN-39D
- AN-39R
- NX-39WR
- QC-01
- NA39S110
- CC-42M
- MC-90SS2
- WS-13
- ST-88S
- EC-04 series
- EC-39D series
- EC-39R series
- 59GPS series

#### Outdoor Microphone MS-11A

- **Microphone**
  - 1/2 inch electret microphone

- **Nominal outer diameter**
  - 13.2 mm

- **Sensitivity level**
  - -27 dB (re 1 V/m at 1 kHz, reference environment)

- **Built-in sound source**
  - 250 Hz, 500 Hz, 1 kHz, 4 kHz (for operation checking)

- **Heater**
  - **Heater current**
    - 94 mA DC
  - **Heater power consumption**
    - 0.9 W

- **Ambient conditions for operation**
  - -20 °C to +50 °C, 100 % RH or less (no condensation)

- **Storage temperature range**
  - -10 °C to +50 °C

- **Dimensions and weight**
  - Outer diameter: 16 mm x 141.3 mm / approx. 120 g
Real Sound Recording Software NX-39WR

<table>
<thead>
<tr>
<th>Function</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>For real sound recording/analysis</td>
<td>Records the sound pressure level waveform obtained from the sound level meter of the NA-39A as a file.</td>
</tr>
<tr>
<td>File format</td>
<td></td>
</tr>
<tr>
<td>Data format</td>
<td></td>
</tr>
<tr>
<td>Bit word length</td>
<td>16/24 bits, selectable</td>
</tr>
<tr>
<td>Sampling frequency</td>
<td>48 kHz</td>
</tr>
<tr>
<td>Frequency characteristics</td>
<td>Z characteristics</td>
</tr>
<tr>
<td>Data volume</td>
<td>Aircraft noise, 40 days (1000 events per day / 5 s duration / mp3):</td>
</tr>
<tr>
<td></td>
<td>Approx. 55 hrs (4 hrs if non-compressed) x 8 GB SDHC card</td>
</tr>
<tr>
<td>Trigger functions</td>
<td></td>
</tr>
<tr>
<td>Event trigger</td>
<td>Recording from Lmax detection when single noise event detection is used</td>
</tr>
<tr>
<td>LTNE event trigger</td>
<td>Recording a part of event sections at multiple locations when constant noise event detection is used</td>
</tr>
<tr>
<td>Interval trigger</td>
<td>Recording starts at constant intervals and continues for a specified duration (Example: Recording 10 minutes in every hour)</td>
</tr>
<tr>
<td>Level trigger</td>
<td>Recording is always performed while the noise level exceeds a certain threshold (interval trigger)</td>
</tr>
</tbody>
</table>

Noise Arrival Direction Identification Unit AN-39D

<table>
<thead>
<tr>
<th>Function</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range</td>
<td>35 dB to 130 dB (no frequency correction)</td>
</tr>
<tr>
<td>Input frequency</td>
<td>20 Hz to 20 000 Hz</td>
</tr>
<tr>
<td>A/D converter</td>
<td>Resolution 24 bits</td>
</tr>
<tr>
<td>Ambient conditions</td>
<td>-10 °C to +50 °C, 90 % RH or less</td>
</tr>
<tr>
<td>for operation</td>
<td></td>
</tr>
<tr>
<td>Dimensions and weight</td>
<td>200 (H) x 140 (W) x 32.9 (D) mm main unit / Approx. 520 g</td>
</tr>
<tr>
<td>Microphone stay section</td>
<td></td>
</tr>
<tr>
<td>Sensors</td>
<td>Microphone x 4, Preamplifier x 4</td>
</tr>
<tr>
<td>Dimensions and weight</td>
<td>421 (H) x 444 (W) x 323 (D) mm / Approx. 2.6 kg</td>
</tr>
</tbody>
</table>

SSR Receiver Unit AN-39R

<table>
<thead>
<tr>
<th>Function</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable standards</td>
<td>CE marking, WEEE Directive</td>
</tr>
<tr>
<td>Input section</td>
<td></td>
</tr>
<tr>
<td>Antenna</td>
<td>1/4 λ, omnidirectional antenna x 1 (SMA connector)</td>
</tr>
<tr>
<td>Input connector</td>
<td>SMA x 1</td>
</tr>
<tr>
<td>Measurement range</td>
<td>Within approx. 10 km</td>
</tr>
<tr>
<td>Carrier frequency</td>
<td>1090 MHz</td>
</tr>
<tr>
<td>Ambient conditions</td>
<td>-10 °C to +50 °C, 10 % to 90 % RH</td>
</tr>
<tr>
<td>for operation</td>
<td></td>
</tr>
<tr>
<td>Dimensions and weight</td>
<td>200 (H) x 140 (W) x 32.9 (D) mm / Approx. 560 kg</td>
</tr>
<tr>
<td>Supplied accessories</td>
<td></td>
</tr>
<tr>
<td>Antenna</td>
<td>1/4 λ, antenna x 1</td>
</tr>
<tr>
<td>Antenna stay x 1 (incl. bolt)</td>
<td></td>
</tr>
</tbody>
</table>

WS-13 Structural Diagram (Unit : mm)

- Outdoor microphone
- Preamplifier with built-in sound source and heater
- 7P microphone extension cable
- Ferrite core

Real Sound Recording Software NX-39WR

For real sound recording/analysis
Records the sound pressure level waveform obtained from the sound level meter of the NA-39A as a file.

File format
Data format
Bit word length 16/24 bits, selectable
Sampling frequency 48 kHz
Frequency characteristics Z characteristics
Data volume Aircraft noise, 40 days (1000 events per day / 5 s duration / mp3): Approx. 55 hrs (4 hrs if non-compressed) x 8 GB SDHC card

Trigger functions
Event trigger Recording from Lmax detection when single noise event detection is used
LTNE event trigger Recording a part of event sections at multiple locations when constant noise event detection is used
Interval trigger Recording starts at constant intervals and continues for a specified duration (Example: Recording 10 minutes in every hour)
Level trigger Recording is always performed while the noise level exceeds a certain threshold (interval trigger)

Noise Arrival Direction Identification Unit AN-39D

Main unit
Measurement range 35 dB to 130 dB (no frequency correction)
Input frequency 20 Hz to 20 000 Hz
A/D converter Resolution 24 bits
Ambient conditions -10 °C to +50 °C, 90 % RH or less
for operation
Dimensions and weight 200 (H) x 140 (W) x 32.9 (D) mm main unit / Approx. 520 g
Microphone stay section
Sensors Microphone x 4, Preamplifier x 4
Dimensions and weight 421 (H) x 444 (W) x 323 (D) mm / Approx. 2.6 kg

SSR Receiver Unit AN-39R

Applicable standards CE marking, WEEE Directive
Input section
Antenna 1/4 λ, omnidirectional antenna x 1 (SMA connector)
Input connector SMA x 1
Measurement range Within approx. 10 km
Carrier frequency 1090 MHz
Ambient conditions -10 °C to +50 °C, 10 % to 90 % RH
for operation
Dimensions and weight 200 (H) x 140 (W) x 32.9 (D) mm / Approx. 560 kg
(Mounting on 22 mm dia. and 32 mm dia. microphone stands supported)
Supplied accessories Antenna: 1/4 λ, antenna x 1
Antenna stay x 1 (incl. bolt)