Multi-Channel Signal Analyzer SA-02M

4-Channel Signal Analyzer SA-02A4
Multi-Channel Signal Analyzer SA-02 Combines 1/1, 1/3, 1/12 Octave Band Analysis Capability

- Up to 32 channels supported (using two SA-02M units)
- Allows high frequency analysis in multiple channels
- Direct sensor connection
- Various analysis software available
- Customizing of analysis software also possible
- Easy operation

By linking two SA-02M units, up to 32 channels are supported
FFT Analysis and

4 channels fixed
Compact size

4-Channel Signal Analyzer
SA-02A4 4ch
4 channels fixed
Compact size

Rear panel (connector section)
SA-02M

LAN connector (for connection to computer)
BNC inputs
Signal outputs (optional)

Rear panel (connector section)
SA-02A4

BNC input connectors
Rotary pulse input connector
Signal outputs (optional)
Power supply input

Inter-unit connector (for linking 2 units)
Trigger input connector
AC output connector
LAN connector (for connection to computer)
Connection Examples

Sound level measurement

<table>
<thead>
<tr>
<th>Calibrator</th>
<th>Microphone</th>
<th>Conversion Adapter</th>
<th>Preamplifier</th>
<th>Preamplifier/Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pistonphone NC-72A</td>
<td>UC-29, UC-54</td>
<td>UA-12</td>
<td>NH-05A</td>
<td>Sound Level Meter Unit UN-14</td>
</tr>
<tr>
<td>Sound Calibrator NC-75</td>
<td>UC-30, UC-31, UC-33P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UC-32, UC-34P</td>
<td>NH-17</td>
<td>NH-17A</td>
<td>EC-04 series (7-pin)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NH-12A (1.5 m)</td>
<td>EC-04 (2 m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NH-04A</td>
<td>EC-04A (5 m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NH-05A</td>
<td>EC-04B (10 m)</td>
</tr>
<tr>
<td></td>
<td>UC-27, UC-32P</td>
<td>UA-10</td>
<td>NH-04A</td>
<td>EC-04C (50 m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NH-06A</td>
<td>EC-04D (150 m)</td>
</tr>
<tr>
<td></td>
<td>UC-30, UC-31, UC-33P</td>
<td>EC-04 series (7-pin)</td>
<td></td>
<td>EC-04E (100 m)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>UC-52, UC-53A, UC-57, UC-59</td>
<td>NH-22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC-04 series (7-pin)</td>
<td>NH-22T</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teds compliant</td>
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<td>TEDS compliant</td>
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Vibration measurement

Amplifier/Adapter
- Charge Converter VP-40
- BNC Joint Connector VP-54C
- EC-90 series (BNC)
  - EC-90A (2 m)
  - EC-90B (5 m)

Cable
- VP-51A
- VP-51A
- VP-51J
- VP-51L
- VP-51A
- VP-51B (Heat-resistant)
- VP-51B (Heat-resistant)
- VP-51 I (Heat-resistant)
- VP-51C (Triaxial)
- VP-51L x3
- VP-51A
- VP-51LC
- VP-51L
- VP-51W (Triaxial, for PV-97I)

Piezoelectric Accelerometer
- General-purpose
  - PV-85/86
  - PV-94/95
- Compact/lightweight
  - PV-08A
  - PV-90B
- High-output
  - PV-87
- High-temperature
  - PV-44A
  - PV-65
  - PV-63
- Triaxial
  - PV-93
  - PV-97C
- Reference piezoelectric accelerometer
  - PV-03 (Reference for secondary calibration)
- With integrated amplifier
  - PV-90T
  - PV-91C
  - PV-971 (Triaxial)
- Low-frequency vibration measurement
  - Servo accelerometer
    - LS-10C
    - LS-40C

Extension cables
- EC-40A (5 m), EC-40B (10 m)
- EC-40C (30 m), EC-40D (50 m)

*Other vibration level meters can also be connected. *UV-16 and VM-83 are not TEDS compliant.
Auto-correlation function
This function is used to measure synchronism and affinity conditions within the signal. It is effective in identifying periodic signal occurrences that were buried in random noise.

Cross-correlation function
By determining affinity between two types of signals, this function allows measuring time lag, transmission path characteristics, and other properties. It is useful for detecting mutual interdependence between signals.

Time waveform recording
This function allows storing of the time waveform in the memory of the computer. The available recording time depends on the memory capacity of the computer, the number of channels, and the frequency range.

FFT analysis
When a composite signal that seems to have an irregular pattern is analyzed using Fast Fourier Transform (FFT), certain patterns can be identified and frequency spectrum analysis becomes possible. This technique is particularly effective for examining an audio signal, and it is also widely used in acoustic and vibration signal analysis for applications such as quality evaluation of automobiles or electrical household goods, detection of unusual sounds that are indicative of problems, etc.

Power spectrum map, octave map
Using the results of power spectrum and octave band analysis, the time can be plotted on the horizontal axis and the frequency and level can be plotted with different colors on the vertical axis. This results in a display that resembles a voice print analysis screen, providing a visualization of signal level fluctuations.

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Amplitude probability density function

By numerically determining the probability within a certain amplitude, the statistical properties of a fluctuating signal can be assessed and analyzed.

Basic screen layout

Transfer function, coherence function

The transfer function indicates a ratio between input signal and output signal in the frequency domain, which is displayed as amplitude and phase. The coherence function determines affinity between two signals in the frequency domain. It is expressed as a numeric value between 0 and 1. When the value is close to 0 for a given frequency, correlation between the two signals is low. Higher values tending towards 1 indicate increasing affinity between the two signals. The coherence function is used to evaluate the transfer function results. It is effective for applications such as S/N ratio measurement and determination of sound source influence ratio.

Octave band analysis

One octave is defined as the interval between two points with a frequency ratio of 1:2. An octave bandpass filter therefore is a filter where the upper limit frequency is double that of the lower limit frequency. When performing analysis with the aim of evaluating noise levels or vibration levels and devising countermeasures, octave band filters (1/1 octave, 1/3 octave, 1/12 octave) are usually applied to provide correlation to human sensory perception.

The graph displays the result of octave band analysis. The horizontal axis represents the time and the vertical axis the magnitude of the signal. Major features of octave band analysis are (1) fewer setting items than for FFT analysis, and (2) frequency resolution is logarithmic, which resembles the way such phenomena are perceived by humans. With this type of analysis, the $L_{eq}$, $L_{max}(AP)$, $L_{max}(Band)$, and $L_e$ values can be calculated for each frequency band.

Recall processing

The results of octave band analysis are used for secondary arithmetic processing.

Octave band analysis offers a so-called "store mode" which allows saving the analysis results at specified intervals during measurement. By recalling these results and performing arithmetic processing on the data, (1) variations over time can be observed, (2) the analysis result for a specific moment can be displayed, and (3) the processing values ($L_{eq}$, $L_{max}$, $L_e$) for a specified range can be displayed.

Overlay display

Several FFT analysis results can be superimposed on screen. This is highly effective for example to judge before/after conditions or to perform visual pass/fail evaluation of data.
Optional Software

Throughput Disk  **CAT-SA02-TH**  (This software is a product of Catec Inc.)

**Long-term time waveform recording**
This software enables directly storing time waveform data on the hard disk of a computer for long-term recording. Data stored on the throughput disk can be used for repeated FFT analysis or octave band analysis with different settings. Waveform data from other sources besides the SA-02 can also be handled.

Optional support for the following formats is available:
- TAF/RAF format for TEAC DAT media
- PC-SCAN II format for Sony DAT media
- CSV format specified by Rion for time data

Waveform Data Manipulation Software  **CAT-SA32**  (This software is a product of Catec Inc.)

**Versatile data manipulation**
Digital filtering, moving average processing, integral processing, differential processing and other functions can be easily performed by mouse operation, and the results are displayed immediately.

**FFT processing**
Any part of the waveform can be selected for FFT processing, and the results are displayed immediately.

**Arithmetic processing**
Arithmetic formula can be input (basic arithmetic, trigonometric functions, etc.) and used for data manipulation.

**Overlay display**
Simply by dragging and dropping a channel name, an overlay display can be created quickly. When data from multiple files are shown in overlay mode, movement on the time axis (shifting the start point) is possible by using the mouse.

**Storing manipulated data**
Manipulated data can be stored in CSV or WAVE format, which allows further processing at a later point, or playback as sound.

**Data import function**
Data from a data recorder can be imported for manipulation.

Report Creation Support Tool  **CAT-Report**  (This software is a product of Catec Inc.)

**Excel add-on**
Because this is an Excel add-on, it can be easily accessed via the Excel toolbar. Storing as regular XLS files is also supported. Display and printing are possible even when the tool is not installed.

**Ease of operation**
A simple button click shows an object area on the sheet, which can be resized and repositioned at will (copying also possible). When an object has been created, settings can be changed with a single button.

**XY graph**
Axis settings (maximum value, minimum value, logarithmic axis, etc.) and plot settings (file and channel, etc.) can be made on a dedicated screen with preview capability.
- Any channel can be assigned to the X axis and Y axis.
- Line color, thickness, type, and legend symbols can be specified for each plot.

**Cell linking function**
The information from an object can be reflected automatically in a specified cell (for example the maximum value of the waveform in an XY graph).
External Control Library

(This software is a product of Catec Inc.)

External Control Library for Measurement Hardware

External Control Library for Measurement Software

External Control Library (DDE version) for SA-02 measurement software

DDE Version

CAT-SA02-LIBDDE

This control library (DLL) for SA-02 measurement software can be called from Excel, VB, VC, or LabVIEW. By using this library, measurement start and stop, measurement data transfer function (via memory), and other functions can be controlled. For control operation within the same computer, the DDE version should be used. If control is to be performed among different computers, the LAN (TCP/IP) version is suitable.

External Control Library (LAN version) for SA-02 measurement software

LAN Version

CAT-SA02-LIBLAN

External Control Library for Measurement Hardware

(Lab VIEW Compatible)

CAT-SA02-LIBBLV

This control library (VI, DLL) for SA-02 measurement hardware can be called from LabVIEW, VB, VC, or similar. By using this library, the functions of the SA-02 measurement hardware can be controlled directly, without going through the SA-02 standard software. This makes it possible to configure purpose-built systems. Unlike the external control library for SA-02 measurement software, this library consists of hardware control functions (VI).

MATLAB Link

CAT-SA02-LIBMAT

Allows sending measurement data in real time to MATLAB (via memory), enabling the execution of scripts created in MATLAB. This is equivalent to using MATLAB as the user language of the SA-02. The MATLAB user can make SA-02 measurement settings and then create programs for value analysis within MATLAB, using regular procedures. Measurement and numeric analysis can therefore be implemented in real time.
Dedicated Analysis Software

Airborne Noise/Floor Impact Noise Insulation Measurement Software  AS-20PE5

- Designed for sound insulation measurement of buildings and building materials based on JIS specifications. Measurement and evaluation for the categories of reverberation time, floor impact sound and attenuation, airborne sound, and sound absorption in a reverberation room are possible.

- Applicable standards
  - ISO 354 Acoustics - Measurement of sound absorption in a reverberation room
  - ISO 140-1 Acoustics - Measurement of sound insulation in buildings and of building elements - Part 1: Requirements for laboratory test facilities with suppressed flanking transmission
  - ISO 140-3 Acoustics - Measurement of sound insulation in buildings and of building elements - Part 3: Laboratory measurements of airborne sound insulation of building elements
  - ISO 140-4 Acoustics - Measurement of sound insulation in buildings and of building elements - Part 4: Field measurements of airborne sound insulation between rooms
  - ISO 140-7 Acoustics - Measurement of sound insulation in buildings and of building elements - Part 7: Field measurements of impact sound insulation of floors
  - ISO 717-1 Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation
  - ISO 140-8 Acoustics - Measurement of sound insulation in buildings and of building elements - Part 8: Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a heavyweight standard floor

- Also allows 1/3 octave band acoustic power level measurements, according to specifications for acoustic power level measurements in hemi-anechoic chambers.
- Sound pressure level values are measured in a hemi-anechoic chamber using measurement points arranged on a virtual measurement surface (hemispheric, cuboid). While applying background noise compensation for the sound pressure level at the sound source, the FLAT characteristics acoustic power level and A-weighted acoustic power level values are determined.
- Applicable standards
  - ISO 3745 Acoustics - Determination of sound power levels of noise sources using sound pressure - Precision methods for anechoic and hemi-anechoic rooms
  - ISO 3744 Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering method in an essentially free field over a reflecting plane

Hemi-Anechoic Acoustic Power Level Measurement Software  AS-30PA5

- Supports direct and comparative measurement. Also allows reverberation time measurement.
- Simultaneous power level measurement for up to 32 channels possible (up to 8 channels for reverberation time measurement).
- Applicable standards
  - ISO 3741 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for reverberation test rooms

Anechoic Acoustic Power Level Measurement Software  AS-31PA5

- Applicable standards
  - ISO 3741 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for reverberation test rooms
Loss Factor Measurement Software AS-14PA5

Calculates acoustic intensity and performs graphics processing. Displays frequency spectrum, band level, and intensity spectrum information as spectrum line diagram, contour diagram, or mesh diagram, and shows acoustic power levels.

* Using the center excitation method or cantilever method, the frequency response of a strip specimen is measured, and the resonance characteristics are used to determine the loss factor and Young's modulus (or shear coefficient) of the specimen according to the half-power bandwidth method.
* Automatic measurement including temperature control of a thermostatic chamber is supported.

Acoustic Intensity Measurement Software AS-15PA5

Calculates acoustic intensity and performs graphics processing. Displays frequency spectrum, band level, and intensity spectrum information as spectrum line diagram, contour diagram, or mesh diagram, and shows acoustic power levels.

* When performing vibration attenuation testing for non-constraint compound damping, "Monogram display of damping material characteristics" is supported with optional software.

Sound Source Location Software AS-16PA5

Determines sound incident direction using a 3-axis acoustic intensity probe, and displays it on screen along with a camera image. Overlays presumed sound source location with captured image and allows selecting the frequency (range) to analyze. Also supports moving sound source measurement on video (option).
Dedicated Analysis Software

Tracking Analysis Software  CAT-SA02-Order  (This software is a product of Catec Inc.)

- Rotation data and sound/vibration data are recorded simultaneously to analyze the rotation order ratio.
- Available display formats include three-dimensional mapping, Campbell diagram, rpm-level display and more.

Mode Analysis Software  ME'Scope VES  (This software is a product of Vibrant Technology Inc.)

- Allows direct linking of SA-02 and mode analysis software.
- Measurement points and direction for each channel can be displayed on screen using arrows, making it easy to check the next measurement point.
- Analysis using animated display can be generated in a few steps.

Sound Quality Evaluation Software  CAT-SA02-SQ  (This software is a product of Catec Inc.)

- WAVE data collected with the SA-02 and similar data can be imported into a measurement data file and used to calculate psychoacoustic evaluation quantities.
- Calculates loudness (steady-state and transient*), sharpness, roughness, intensity fluctuation, and tonality evaluation parameters.  *Calculation of transient loudness available as an option.

Array Type Visualization Software  CAT-SA02-AR  (This software is a product of Catec Inc.)

- Sound pressure level fluctuations and changes are made visible using a 32-microphone array.
- Visualization can be performed separately by frequency or overall. Microphone frequency analysis results can be displayed for each mode.
- Power spectrum and 3-D spectrum map can be observed for each array element, based on sound pressure level at the measurement position.
  Overlay with image data from a digital camera or similar is also possible.
Dual-sensor arrangement using a combination of microphone and accelerometer allows reliable noise detection by canceling out external noise.

High degree of correlation to values measured in an anechoic chamber or anechoic box. Also suited for noise tests on HDDs for audio and video applications where a quiet environment is essential.

Applicable standards ISO 8041 Human response to vibration - Measuring instrumentation
ISO 5349-2 Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration - Part 2: Practical guidance for measurement at the workplace

Frequency-weighted acceleration rms values are measured for the X, Y, Z axes simultaneously. From these values ($a_{hx}$, $a_{hy}$, $a_{hz}$), the software determines the triaxial combined value $a_v$.

Hand-arm Vibration Measurement Software CAT-SA02-HT (This software is a product of Catec Inc.)

ISO 6395 Earth-moving machinery - Determination of sound power level - Dynamic test conditions
ISO 6393 Earth-moving machinery - Determination of sound power level - Stationary test conditions

Using an Excel macro, the acoustic power level of construction machinery can be measured.

Construction Machinery Acoustic Power Level Measurement System CAT-SA02-CPWL (This software is a product of Catec Inc.)

Envelope Analysis Software CAT-SA02-ENV (This software is a product of Catec Inc.)

- Designed for bearing problem diagnosis
- Envelope analysis produces equidistant peaks.
- When the bearing part dimensions, number of rolling elements, axis rpm and other parameters are known, the primary frequency of the aligned peaks can be used to pinpoint problem locations.
Rion is offering a range of optional software for various measurement scenarios, but we can also further customize the software to adapt to the specific needs of our customers. This can provide a further efficiency boost for production line testing and for research and development applications.
Some customization examples

**Car interior noise measurement system**

- Using the SA-02, this system is designed to allow easy measurement of vibrations occurring in a running car.
- The system covers all steps from tracking analysis to report creation.

**Train vibration noise measurement system**

- This vibration noise analysis software enables the SA-02 to be used for measuring train noise.
- Vibrations and noise caused by the passing of a train can be analyzed and a report can be created with a few simple steps.

**Automatic measurement system for washing machine vibrations**

- Vibrations occurring at various stages of the washing machine cycle (water inflow, washing, spin dry etc.) are measured and recorded, along with rpm data. The system then automatically compiles maximum values for each stage in a list and creates a report.
This product is environment-friendly. It does not include toxic chemicals on our policy.

This leaflet is printed with environmentally friendly UV ink.

**Specifications**

**Input section**

- **Number of channels**: 4 channels
- **Connectors**: BNC x number of channels
- **Max. input voltage**: ±20 V
- **Input impedance**: 100 kΩ

**Amplifier section**

- **Frequency range (DC to 40 kHz)**
- **Analog filters**
  - **High pass filter (HPF)**: OFF / 20 Hz (-1.0 dB, 18 dB/oct)
  - **Low pass filter (LPF)**: OFF / 1 kHz (-1.0 dB, 18 dB/oct)
- **Overload level**: ±85 dB or less (all-pass level, 0 dB range) / ±105 dB or less (all-pass level, ≈-40 dB range)

**AD converter section**

- **Sampling frequency**: 102.4 kHz
- **Number of analysis points**: 64 / 128 / 256 / 512 / 1024 / 2048 / 4096 / 8192 / 16384 / 32768
- **Overlap ratio**: 0 % / 50 % / 75 % / 87.5 % / 93.75 %

**FFT analyzer section**

- **Analysis band range**: 0.5 Hz / 2 Hz / 5 Hz / 10 Hz / 20 Hz / 40 Hz
- **Analysis window**: Rectangular / Hanning / Flat-top / Exponential / Force Exponential

**Octave band analyzer section**

- **Bandwidth**: 0.2 Hz / 0.5 Hz / 1 Hz / 2 Hz / 4 Hz / 5 Hz / 10 Hz / 20 Hz / 40 Hz
- **Processing functions**: Linear averaging / Exponential averaging / Maximum value detection (every 100 ms)

**Memory section**

- **Memory**: Instantaneous value / linear average value / maximum value / tacho pulse (only with compatible software)
- **Storage capacity**: 1 ms / 10 ms / 30 ms / 125 ms / (P) / 630 ms / (V) / 1 s / 10 s

**Display section**

- **Number of windows**: 2 / 4 / 8 / 16 / 32
- **ADC output connectors**: Type: 2.5 mm mono mini jack x number of channels
- **Trigger input connectors**: Type: 2.5 mm mono mini jack x 1
- **Rotary pulse input connectors**: Type: BNC x 1

**Power section**

- **Supply principle**: AC adapter NC-99 (supplied)
- **Power consumption**: SA-02M: approx. 40 VA (4 channels installed) / approx. 30 VA (8 channels installed) / approx. 20 VA (16 channels installed)

**Environmental conditions for use**

- **Temperature**: 0 °C to 40 °C, max. 90 % RH (no condensation)

**Recommended computer specifications**

- **CPU**: Intel Core i5 / i7 1.4 GHz or higher (Core 2 Duo 2 GHz or higher)
- **RAM**: 2 GB or more
- **Display**: XGA (1024 x 768) or higher, 65,536 colors or more
- **Operating system**: Microsoft Windows 7 Professional 32 bit / 64 bit, 8.1 Pro 32 bit / 64 bit, 10 Pro 32 bit / 64 bit

**Windows** is a trademark of Microsoft Corporation. + Specifications subject to change without notice.

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RION Co., Ltd.
3-20-41, Higashimotomachi, Kokubunji, Tokyo 185-8533, Japan
Tel: +81-42-359-7888  Fax: +81-42-359-7442

RION CO., LTD.
https://rion-sv.com/