



# Scope of Performance

**CadnaR** is the powerful software tool for all professionals who deal with the acoustical planning of rooms and noise mitigation at workplaces. Dependent on area of application and budget the CadnaR Base-Module can be combined with one or several CadnaR Options to extend the functionality. Details about the features of the Base-Module and the different options are listed in this document.

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The information presented in this document refers to **CadnaR 2024 MR1** (March 2024) and is subject to changes without notice.

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# 1 Overview CadnaR Base-Module and CadnaR Options

## CadnaR Base-Module

**Precondition for the usage** of all CadnaR options. Image source and particle calculation method (not in combination). Source types limited to point sources. Any type of obstacle allowed (barrier, box-type-obstacle, polymesh). Calculation of sound pressure levels at single receiver points. Import of textfiles (ASCII – format) for geometries, spectra and directivities, IFC-Import, CLF-Import, Import from SketchUp. For the time being also included in the Base-Module: Import from CadnaR.scan App (\*.eox).

### Option VIS (Visualization)

Visualization of the calculation (calculation rays in 3D, particle animation etc.) for checking the model, to get a deeper understanding of the results and for presentation purposes. Usage of high-resolution bitmaps (e.g. as layout plan). Import of textured 3D-Objects for presentation purposes.

### Option CAL (Calculation & handling)

Enormously increased performance. Additional calculation methods. Batch calculation. Further source types (e.g. line source, area source). Calculation and visualization of the voxel grid. Usage of Receiver Chains. Plot designer. Automatic calibration of absorption and scattering coefficients to achieve user-defined target reverberation time. Dosimeter.

### Option ORG (Project organization)

Massive improvements in organization and handling of projects of any size. Grouping of objects (ObjectTree). Usage of variants. Efficient handling and comparison of up to 16 scenarios in a single file. Calculation of partial levels. CUDA calculation. Import of DWG and DXF file formats. Automatic calibration of complex source structures as e.g. machines.

### Option AUDIO

Auralization and calculation of room acoustic and psychoacoustic parameters. Calculation of energetic impulse responses, echograms, reverberation time (T10, T20, T30), Speech Transmission Index (STI). Calculation of further parameters like e.g. Alcons, C80, D50, CIS and EDT.

### Option OFFICE

Selected features from both options CAL and ORG for the handling, evaluation and optimization of offices and open plan offices. Usually to be combined with option T (or option AUDIO).

### Option T

Selected features from option AUDIO for the calculation and graphic representation of the reverberation time (T20, T30).

### Option SET (Sound emission & transmission)

Expert option allowing for example the calculation of frequency spectra of radiated sound power determined from the technical parameters of a sound source. Modeling of complex devices with multiple sound sources and radiating areas, reproducing their inner sound flux and transmission to connected parts.

## 2 Technical Spezifikation of CadnaR

### 2.1 Calculation methods

Feature	CadnaR Base-Module	Options						
		CAL	VIS	ORG	AUDIO	OFFICE	T	SET
<b>Image source model</b>	<input checked="" type="checkbox"/>							
<b>Particle model</b>	<input checked="" type="checkbox"/>							
<b>Combined image source and particle model</b> (Hybrid method)		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>		
<b>Diffuse field statistical method</b>		<input checked="" type="checkbox"/>						
<b>Calculation according to VDI 3760</b>		<input checked="" type="checkbox"/>						
<b>Maximum order of reflection</b> (Image source method)	20							
<b>Horizontal and vertical diffraction</b> (Image source method)	<input checked="" type="checkbox"/>							
<b>Maximum order of reflection</b> (Particle method)	500							
<b>Sigma criterium</b> to avoid unreasonably low particle numbers (Particle method)	<input checked="" type="checkbox"/>							
<b>Estimation of maximum runtime for particles</b> (Particle method)	<input checked="" type="checkbox"/>							
<b>Acoustical properties of obstacles: absorption</b> Available with all calculation methods	<input checked="" type="checkbox"/>							
<b>Acoustical properties of obstacles: transmission</b> Available with particle calculation method only	<input checked="" type="checkbox"/>							
<b>Acoustical properties of obstacles: scattering</b> Available with particle calculation method only	<input checked="" type="checkbox"/>							
<b>Edge scattering</b> Available with particle calculation method only	<input checked="" type="checkbox"/>							
<b>Scattering through roughness</b> Available with particle calculation method only	<input checked="" type="checkbox"/>							
<b>Diffraction of particles</b> Available with particle calculation method only	<input checked="" type="checkbox"/>							
<b>Calculation with CUDA</b> Requires NVIDIA graphics card with at least compute capability 5.0 (Available with particle calculation method only)				<input checked="" type="checkbox"/>				
<b>Batch calculation</b>		<input checked="" type="checkbox"/>						

- included (in Base-Module or Option)
- needed as pre-requisite

## 2.2 Source object types

Feature	CadnaR Base-Module	Options						
		CAL	VIS	ORG	AUDIO	OFFICE	T	SET
<b>Point source</b>	<input checked="" type="checkbox"/>							
<b>Line source</b>		<input checked="" type="checkbox"/>						
<b>Horizontal area source</b>		<input checked="" type="checkbox"/>						
<b>Vertical area source</b>		<input checked="" type="checkbox"/>						
<b>Box-type source</b>		<input checked="" type="checkbox"/>						
<b>3D directivity</b> (Point sources only)	<input checked="" type="checkbox"/>							
<b>Simplified directivity</b> (Point sources only)	<input checked="" type="checkbox"/>							
<b>Emission sound pressure level SPL for source groups</b>				<input checked="" type="checkbox"/>				
<b>Free field simulation for source groups</b>				<input checked="" type="checkbox"/>				
<b>Source group calibration</b>				<input checked="" type="checkbox"/>				
<b>Calculation of sound power from the technical parameters of a sound source</b>								<input checked="" type="checkbox"/>
<b>Database of source modules based on technical parameters</b> (306 source modules included)								<input checked="" type="checkbox"/>
<b>User-defined sound source modules based on technical parameters</b>								<input checked="" type="checkbox"/>
<b>Calculation of sound power level of complex interconnected source systems, considering radiation and transmission</b>								<input checked="" type="checkbox"/>

- included (in Base-Module or Option)
- needed as pre-requisite

## 2.3 Further object types

Feature	CadnaR Base-Module	Options						
		CAL	VIS	ORG	AUDIO	OFFICE	T	SET
<b>Barrier</b>	<input checked="" type="checkbox"/>							
<b>Box-type obstacle</b>	<input checked="" type="checkbox"/>							
<b>PolyMesh and vertical PolyMesh</b>	<input checked="" type="checkbox"/>							
<b>Height point</b> (Inner point of the PolyMesh)	<input checked="" type="checkbox"/>							
<b>Contour line</b> (Inner line of the PolyMesh)	<input checked="" type="checkbox"/>							
<b>Receiver</b>	<input checked="" type="checkbox"/>							
<b>Receiver Chain</b>		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>		
<b>High resolution bitmap</b>			<input checked="" type="checkbox"/>					
<b>Section</b>	<input checked="" type="checkbox"/>							
<b>Text box</b>	<input checked="" type="checkbox"/>							
<b>Auxiliary polygon</b>	<input checked="" type="checkbox"/>							
<b>Symbol</b>	<input checked="" type="checkbox"/>							
<b>3D Symbol</b>			<input checked="" type="checkbox"/>					
<b>Calculation area</b>		<input checked="" type="checkbox"/>						
<b>Vertical grid</b>		<input type="checkbox"/>	<input checked="" type="checkbox"/>					
<b>3D grid</b>		<input type="checkbox"/>	<input checked="" type="checkbox"/>					

- included (in Base-Module or Option)
- needed as pre-requisite

## 2.4 Calculation results and postprocessing

Feature	CadnaR Base-Module	Options						
		CAL	VIS	ORG	AUDIO	OFFICE	T	SET
Calculation of sound pressure levels at receiver points	<input checked="" type="checkbox"/>							
Diagram sound pressure level spectra (Receivers)	<input checked="" type="checkbox"/>							
Diagram of spatially averaged sound pressure level spectra (Receivers)	<input checked="" type="checkbox"/>							
NC (Noise Criteria) and NR (Noise rating) for receiver points	<input checked="" type="checkbox"/>							
Partial sound pressure levels at receiver points				<input checked="" type="checkbox"/>				
Dosimeter		<input checked="" type="checkbox"/>		<input type="checkbox"/>				
Calculation protocol (image source model only)				<input checked="" type="checkbox"/>				
Calculation of Receiver Chains		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>		
Horizontal Grid calculation (2D)		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>		
Voxel Grid calculation (3D)		<input checked="" type="checkbox"/>						
Arithmetic of Grids (up to 7 grids)		<input checked="" type="checkbox"/>						
Generation and evaluation of an enveloping surface consisting of a mesh of Receivers		<input checked="" type="checkbox"/>						
Level evaluation of Receiver Chains (Diagram, L_p,A,S,4m, D_2,S)		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>		
STI evaluation of Receiver Chains (Diagram, r_D, r_P) <input type="checkbox"/> _1 Option CAL or OFFICE is pre-requisite		<input type="checkbox"/> _1			<input checked="" type="checkbox"/>	<input type="checkbox"/> _1		
Diagram of reverberation times (Receiver)					<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Calculation of the energy-based room impulse response at receivers					<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Diagram echogram (Receivers)					<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Diagram of reverberation times (Receiver Chains) <input type="checkbox"/> _1 Option CAL or OFFICE is pre-requisite		<input type="checkbox"/> _1			<input checked="" type="checkbox"/>	<input type="checkbox"/> _1	<input checked="" type="checkbox"/>	
Diagram of spatially averaged reverberation times (Receivers)					<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Diagram of spatially averaged reverberation times (Grid) <input type="checkbox"/> _1 Option CAL or OFFICE is pre-requisite		<input type="checkbox"/> _1			<input checked="" type="checkbox"/>	<input type="checkbox"/> _1		
Requirements for reverberation times (VDI 2569, DIN 18041, ASR 3.7, UNI 11532-2)					<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Early decay time (EDT), Reverberation time T10					<input checked="" type="checkbox"/>			
Reverberation time T20 and T30					<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Definition / Clarity (D50 and C50), Clarity index for music (C80), Center time (TS)					<input checked="" type="checkbox"/>			
Articulation loss (Alcons%), Common intelligibility scale (CIS)					<input checked="" type="checkbox"/>			
Speech transmission index - male / female According to IEC 60268-16:2011 (STI_male   STI_female)					<input checked="" type="checkbox"/>			
STI for public address systems (STIPA_IR)					<input checked="" type="checkbox"/>			
Grid calculation for quality criteria (with option T, only T20 and T30)		<input type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Estimate mean absorption coefficient from T20					<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Automatic calibration of absorption and scattering coefficients to achieve user-defined target reverberation time. <input type="checkbox"/> _1 Option AUDIO or T is pre-requisite		<input checked="" type="checkbox"/>			<input type="checkbox"/> _1		<input type="checkbox"/> _1	

- included (in Base-Module or Option)
- \_1 needed as pre-requisite

## 2.5 Import and export formats

Feature	CadnaR Base-Module	Options						
		CAL	VIS	ORG	AUDIO	OFFICE	T	SET
<b>Import from SketchUp</b> (.skp)	<input checked="" type="checkbox"/>							
<b>Import from CadnaR.scan App</b> (*.eox) Included in Base-Module for the time being	<input checked="" type="checkbox"/>							
<b>Import of bitmap files</b>			<input checked="" type="checkbox"/>					
<b>Import of .dwg files</b> (AutoCAD 2013, pCon planner)				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		
<b>Import of .dxf files</b> (AutoCAD, pCon planner)				<input checked="" type="checkbox"/>				
<b>Import of IFC4 STEP files</b> (.ifc)	<input checked="" type="checkbox"/>							
<b>Import of ASCII Object geometry files</b>	<input checked="" type="checkbox"/>							
<b>Import of ASCII Spectra files</b> (e.g. spectral absorption and sound power level data)	<input checked="" type="checkbox"/>							
<b>Open *.spa files</b> from the "SchallPrognoseApp(SPA)" of the German Federal Institute for Occupational Safety and Health (BAUA)	<input checked="" type="checkbox"/>							
<b>ODBC interface</b>				<input checked="" type="checkbox"/>				
<b>Direct import from MS Excel files</b> (.xlsx)				<input checked="" type="checkbox"/>				
<b>Import of directivity files</b> (ASCII)	<input checked="" type="checkbox"/>							
<b>Import of CLF directivity files</b> (.cf1 / .cf2)	<input checked="" type="checkbox"/>							
<b>Import of XHN directivity files</b>	<input checked="" type="checkbox"/>							
<b>Library manager</b>				<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>
<b>Export of reports based on predefined MS Excel Templates</b> (MS Excel (.xlsx))				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		
<b>Export of full customizable reports to MS Office</b> (MS Word (.docx)   MS Excel (.xlsx))				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		
<b>Export to AutoCAD</b> (.dxf)	<input checked="" type="checkbox"/>							
<b>Export of 2D ASCII - Grids</b> (.rst)		<input checked="" type="checkbox"/>						
<b>Export of 2D ASCII Grids</b> (.txt, .csv, .dat)		<input checked="" type="checkbox"/>						
<b>Export of 3D voxel grids</b> (.cnivg)		<input checked="" type="checkbox"/>						

- included (in Base-Module or Option)
- needed as pre-requisite

## 2.6 Modelling tools and project organization

Feature	CadnaR Base-Module	Options						
		CAL	VIS	ORG	AUDIO	OFFICE	T	SET
<b>Single object actions</b> Duplicate, Convert to, Transform, Label, Parallel Object	<input checked="" type="checkbox"/>							
<b>Single object actions</b> Break Lines, Break Areas, Create Poly with n-Edges, Simplify Geo, Spline, Modify Order of Points, Snap point to obstacle, Change ObjectTree assignment, Break into Pieces, Connect Lines, Set Length, Normalize rotation angles	<input checked="" type="checkbox"/>							
<b>Single object actions</b> Deconstruct box-type source, Generate machine		<input checked="" type="checkbox"/>						
<b>Multiple object actions</b> Delete, Convert, Transform, Delete Duplicates, Activation, Normalize rotation angles	<input checked="" type="checkbox"/>							
<b>Multiple object actions</b> Simplify Geometry, Spline, Modify Order of Points, Break into Pieces, Snap point to obstacle, Change ObjectTree assignment, Connect Lines				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		
<b>Multiple object actions</b> Modify Attributes, Duplicate, Label, Parallel Object				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		
<b>Creation of up to 16 scenarios or variants</b>				<input checked="" type="checkbox"/>				
<b>Object Tree</b> Group objects for interactive group editing with mouse and keyboard				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		
<b>Object Tree (full functionality)</b> Including partial levels and sound power levels for groups				<input checked="" type="checkbox"/>				
<b>Assignment of groups to variants</b>				<input checked="" type="checkbox"/>				
<b>Copy group activation</b>				<input checked="" type="checkbox"/>				
<b>Comparison of variants in diagram of reverberation times</b> (Receiver, Receiver Chains) <input type="checkbox"/> <sub>1</sub> Option CAL or OFFICE is pre-requisite to be able to use Receiver Chains <input type="checkbox"/> <sub>2</sub> Option AUDIO or T is pre-requisite to be able to calculate reverberation time		<input type="checkbox"/> <sub>1</sub>		<input checked="" type="checkbox"/>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	
<b>Comparison of variants in diagram of spatially averaged reverberation times (Receiver)</b> <input type="checkbox"/> Option AUDIO or T is pre-requisite to be able to calculate reverberation time				<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	
<b>Comparison of variants in tables of spatially averaged reverberation times (Receivers, Receiver Chains)</b> <input type="checkbox"/> <sub>1</sub> Option CAL or OFFICE is pre-requisite to be able to use Receiver Chains <input type="checkbox"/> <sub>2</sub> Option AUDIO or T is pre-requisite to be able to calculate reverberation time		<input type="checkbox"/> <sub>1</sub>		<input checked="" type="checkbox"/>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	

- included (in Base-Module or Option)
- needed as pre-requisite



## 2.7 Visual and aural presentation of results

Feature	CadnaR Base-Module	Options						
		CAL	VIS	ORG	AUDIO	OFFICE	T	SET
<b>Open-GL based 3D Visualization</b>	<input checked="" type="checkbox"/>							
<b>Selection and editing of objects in 3D view</b>	<input checked="" type="checkbox"/>							
<b>Free movement and save up to 4 predefined views in 3D view</b>	<input checked="" type="checkbox"/>							
<b>Appearance of objects in 3D view depending on attributes</b>	<input checked="" type="checkbox"/>							
<b>Further appearance and functionality options for objects in the 3D View</b> Transparency, selectable, direct color	<input checked="" type="checkbox"/>							
<b>Display of calculated sound rays in 3D View</b>			<input checked="" type="checkbox"/>					
<b>Display of 3D Iso—Faces</b> within the 3D view		<input type="checkbox"/>	<input checked="" type="checkbox"/>					
<b>Display of 3D Iso— Lines</b> within the 3D view		<input type="checkbox"/>	<input checked="" type="checkbox"/>					
<b>Display of 3D Iso— Lines</b> (Height is level) within the 3D view		<input type="checkbox"/>	<input checked="" type="checkbox"/>					
<b>Vertical grid in 2D and 3D view</b>		<input type="checkbox"/>	<input checked="" type="checkbox"/>					
<b>3D grid in 2D and 3D view</b>		<input type="checkbox"/>	<input checked="" type="checkbox"/>					
<b>Particle animation</b> (particle ping—pong) within the 3D view			<input checked="" type="checkbox"/>					
<b>Interactive video capturing for Open GL based 3D View</b> (.avi format)			<input checked="" type="checkbox"/>					
<b>Import and visualization of 3D—Symbols</b> (.obj format)			<input checked="" type="checkbox"/>					
<b>Stereoscopic 3D view</b> *3D TV required			<input checked="" type="checkbox"/>					
<b>Plot Designer</b>		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>		
<b>Print reports</b>	<input checked="" type="checkbox"/>							
<b>Projection of bitmap background images in 3D View</b>			<input checked="" type="checkbox"/>					
<b>Auralisation</b> - One source for each receiver - Multiple sources for each receiver					<input checked="" type="checkbox"/>			

### 3 System requirements

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CadnaR can be installed on any system which fulfils the following requirements:

- Multi-core processor from Intel (Core i series, 6th generation, „Skylake“ architecture or newer) or from AMD (Ryzen series, starting from the 1<sup>st</sup> generation, „Zen“ architecture or newer) with at least 4 cores, instruction set extensions SSE 4.2 and AVX as well as 64-bit extensions (Intel 64 or AMD64)
- 8 GB RAM
- OpenGL 3.3 graphics card with minimum 2 GB real graphic memory to use the hardware accelerated 3D-view. Using processor graphics or graphics card with no dedicated graphics memory ("shared memory") may result in display errors. For the accelerated calculation of the particle model with CUDA on the GPU, a NVIDIA graphics card with at least Compute Capability 5.0 (Maxwell architecture) or newer is required.
- Windows 64-bit operating system
  - Microsoft Windows 10 (Version 22H2)
  - Microsoft Windows 11 (Version 22H2 or newer)