Entry Premium

Extraction Secondary Surface "Radome"

ARS 404-21 (Entry)

+

ARS 408-21 (Premium)

Long Range Radar Sensor

SS / HS

"Standard Sensitivity / High Sensitivity"

TR / CL

"TRacks / CLuster"

Technical Data

Version 1.01 en

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ARS 404-21 Entry and ARS 408-21 Premium - Short Description

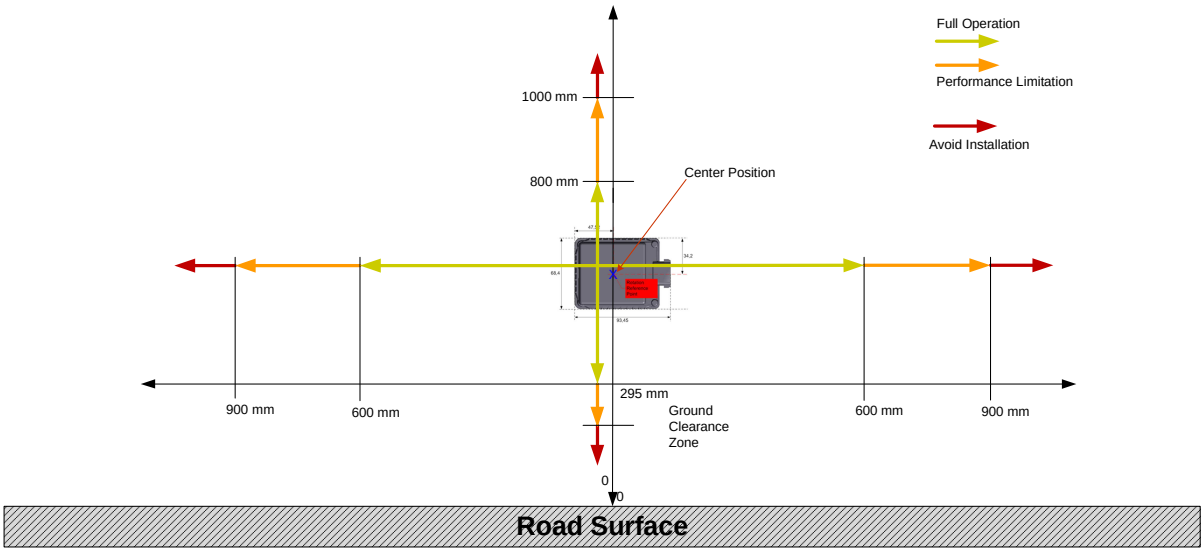

Figure X: Mounting / Installation Location ARS 404 and ARS 408

1.1 Angular Mounting Tolerances

The maximum out of position angles to normal position (sensor-front perpendicular to road surface and perpendicular to vehicle axis) corresponds to alignment capability as given in the section "Calibration and Blockage".

The mechanical mounting tolerances include the **sum** of the following contributions:

- Drive axis-vehicle body
- Vehicle Body-Bracket
- Bracket-Sensor
- Change of loading condition (e.g. empty/full trunk)

The better the accuracy of drive axis-vehicle body the more mounting margin is available for the other contributions. The mounting tolerances have to be new calculated for each new vehicle platform.

The alignment feature of the ARS404 and ARS 408 provides on-line calibration to compensate mounting tolerances and secondary surface effects. Misalignment consist of

- Misalignment in the factory
- Changes over lifetime
- Loading

1.2 Secondary Surface (Radome)

Between the sensor and the exterior of the vehicle there shall be a secondary surface which has to fulfill following functions:

The position and orientation of the ARS404 and ARS 408 system in relation to the bumper / cover plate cannot generally be specified, but has to be evaluated individually.

Configuration for optimum system performance depends on:

- Thickness
- Material
- Form
- Distance
- Homogeneity
- Tilt of the secondary surface

For a given appropriate design of the secondary surface, the system can be configured in such a way, that usage is secure and unaffected even when mounting tolerances within the given limits are taken into account.

As a proposal for nomenclature, the secondary surface is meant for the bumper and radome for radar optimized structures.

1.3 Secondary Surface – Distance and Angle

According to the mounting position of the sensor for a specific platform, the distance between the sensor front cover and the secondary surface shall be designed large enough to avoid mechanical interferences, caused by thermal geometry changes or mechanical stress (e.g. vibrations).

In addition to that, the distance to the secondary surface shall be large enough to avoid development of a constant water film or snow or mud cover. Because of a small antenna aperture the ARS404 variant Continental recommends a minimum distance of 20 mm and the ARS 408 variant Continental recommends a minimum distance of 10 mm to the secondary surface, if the sensor is accessible by rain, snow, mud etc. indirectly.

The angle between sensor and secondary surface is designated as tilt angle.

Small tilt angle could introduce multipath reflection between sensor and secondary surface and might increase noise level, reduce non-ambiguous angle area and might cause ghost object issues.

Higher tilt angle increases the effective thickness and therefore increases damping due to material losses, reduces non-ambiguous angle area and might cause ghost object issues.

For maximum performance the tilt angle shall be $10° < x < 30°$.

Generally the nominal thickness of cover material should be selected according to the minimum loss for the tilt angle.

The combination of large tilt angles and large distance to the secondary surface has to be considered with special attention.

- Propagation paths through the engine compartment which can lead to ghost targets.
- Multipath propagation e.g. between bracket and secondary surface resulting in higher sidelobes or inaccurate angular measurement.

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1.4 Secondary Surface – Material Properties

Material properties given by manufacturer normally refer to frequencies in MHz-range and below. For higher frequencies the material properties differ intensely from data sheets.

The roughness of the material should be below lambda/10 (~400 um).

Materials used as structure for the bumper/ secondary surface shall have following properties:

- Synthetic materials with low dielectric loss factors at the specific radar frequency shall be used in order to achieve low transition damping.
- Synthetic materials with low dielectric constants (ε_r) shall be used in order to obtain low surface reflection.

A possible synthetic material that has been approved for usage which is commonly used is ABS, among others. Other possible materials are shown in the Table 1.

Material	Dielectric Constant (ε_r) @ 77 GHz
Polypropylene	2.35
Polyamide	2.75
Polycarbonate	2.8
PC-PBT(Polycarbonate Type)	2.9
ABS (Acrylnitril-Butadien-Styrol)	3.12
ASA (Acrylonitrile Styrene Acrylate)	~3.8
PMMA (Poly Methyl Methacrylate)	~3-4 TBC

Table 1: Dielectric Constant and optimal thickness of common bumper materials @ 77 GHz

Material	thickness of 1.optimum (mm)**	thickness of 2.optimum (mm)**	thickness of 3.optimum (mm)**	thickness of 4.optimum (mm)**	attenuation(dB) for 2. Optimum at 77 GHz	real permittivity Er*	applicability	Lambda/2 free air for 77 GHz	
Polypropylene	1,28	2,55	3,83	5,10	0,10	2,33	best	1,948051948	mm
ABS	1,19	2,39	3,58	4,77	0,30	2,7	ok		
Polyamide	1,18	2,36	3,54	4,72	0,30	2,73	ok		
Polycarbonate	1,16	2,33	3,49	4,66	0,17	2,8	ok		
SMC	0,88	1,77	2,65	3,54	1,10	4,85	no		

*Numbers for permittivity might vary depending on manufacturer and chemical composition. Therefore calculated numbers for thickness have to be verified by measurement

**Calculated numbers for thickness only apply for incident angle of secondary surface of 0 degree.

Table 2: Thickness, Attenuation, Permittivity of possible radome materials

Based on experience it is important to note, that the actual properties of a certain material may also differ from supplier to supplier according to the used composition or density. Therefore, all values for the dielectric constant given in the paragraph can only be used as a guideline.

1.5 Secondary Surface – Thickness and Curvature

To achieve high permeability, the overall thickness of the secondary surface has to be carefully selected. A multiple of half of the effective wavelength within the material would be appropriate. E.g. for the case of ABS material (εr = 3.12) any value of n* 1.1 mm (@77 GHz, n=1,2,..) is favorable. Whereby with raising thickness the attenuation is increasing.

The given formula given above is only applicable for small to medium tilt angles (approx. up to 30°) of the secondary surface against the sensor front.

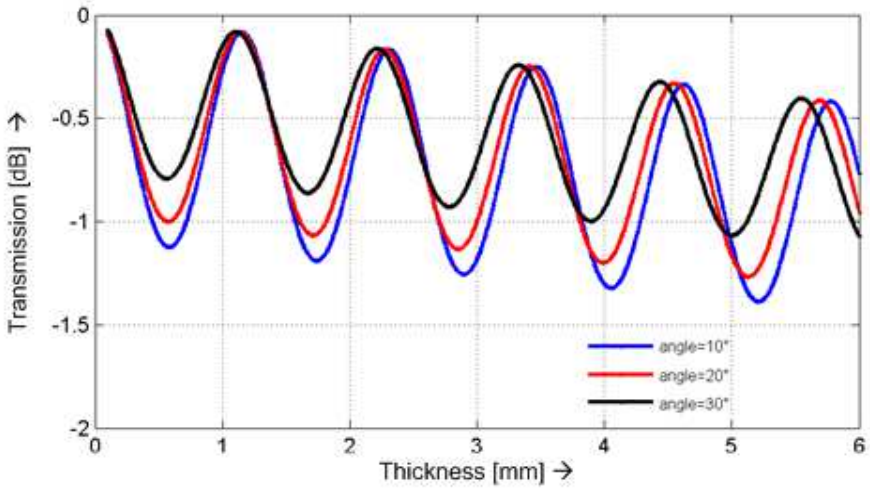

Figure 6: Attenuation in dependency of material thickness and tilt angles

To prevent distortion of the radar beams, the secondary surface shall be as planar as possible while providing constant thickness. Smaller curvature radius results in higher effects to the radar beam.

To prevent distortions of the radar beam, the curvature of the secondary surface shall not contain ribbed profiles, sharp edges or abrupt thickness changes.

The following Figure 7 provide a general impression of favorable boundary conditions.

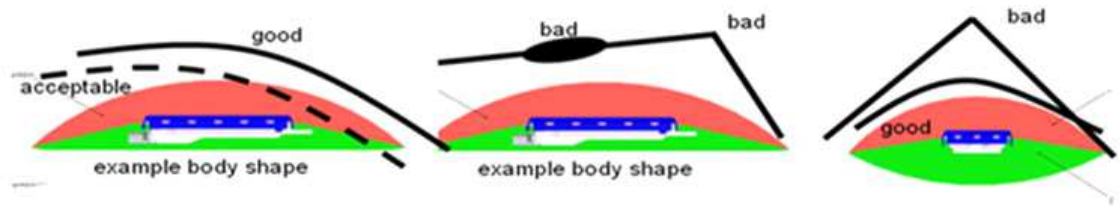

Figure 7: Boundary Conditions

Any specific geometry of the secondary surface including the mounting structure of the radar sensor shall be provided from an expert in order to evaluate impact on functionality and performance of the sensor. Worst case, radar measurements needs to be performed.

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1.6 Secondary Surface – Painting

The secondary surface (radome) can in principle be painted but a dedicated analysis and control of the different possible categories of paintings is mandatory to avoid significant performance degradation.

In general the secondary surface will carry several layers of primer, paint and varnishes. These layers in combination with the structure material will influence both surface reflection properties and the transmission damping. All kinds of metallic materials prevent respectively degrade sensor radiation and shall not be used as a second surface.

Elements containing metallic particles must be verified. The applicability of metallic paintings is dependent on

- The metal content (percentage) in the painting
- The size and shape of the metal particles in the painting
- Number and thicknesses of different layers of paintings and primers

The number of painting layers shall not exceed 4, considering the maximum one-way attenuation.

A summary of all known mechanical design guidelines for painting and structure of the secondary surface is shown in Table 3.

Factor	GO	NO GO	Performance Degradation
Area	No interference within illuminated FoV (no clips, screws, metal parts	Metalic parts inside the FoV	Minor interferences in the outer border of the desired area; dielectric interferences within border of FoV; interferences have to be agreed by Continental
Material	Approved material	All other materials needs to be confirmed by Continental	Non approved materials has to be confirmed by Continental
Thickness	Constant thickness over whole structure as specified	Thickness deviations which leads in combination with material constants to higher attenuations than specified	Minor deviations for desired thickness leeds to reduced reach.
Paint/Color radome	No paint/color	Non-approved paint or varnish	If approved color is used, must specify one layer A side only and Charater Line requirements fully met.
Paint/Color bumber Function EBA	Up to 4 layers if attenuation is within spec	Violation of max. attenuation	
Holes		X	
Characterlines - Vertical	<= 1.0mm if w/o paint	Limits to be clarified	Characterlines are possible if overall thickness is constant. E.g if characterline is extruded to front, inner side of radome has to be intruded to keep thickness constant. Limit of size has to be approved.
Characterlines - Horizontal	<= 1.0mm if w/o paint	Limits to be clarified	Characterlines are possible if overall thickness is constant. E.g if characterline is extruded to front, inner side of radome has to be intruded to keep thickness constant. Limit of size has to be approved.
Characterlines - Curvature	> 320mm based on Continental experience from many application projects	Limits to be clarified	Limits to be clarified
Overall Surface Structure	See specification	Major deviations from specification	Minor deviations from specification
Angle between Sensor/Radome	10°<x<30°	>30°	<10°; the better the radome the smaller possible tilt angle
Distance	>=20mm (exposed environment)	to small distance or violation of radarcone	depends on radarcone and radome performance

Table 3: Requirement for Secondary Surface

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1.7 Secondary Surface – Attenuation

The maximum attenuation of the combined secondary surface (bumper including paint) depends on required function:

- To provide EBA functionality:
  - One-way attenuation shall not exceed 4.0 dB
  - Max. reflection coefficient shall not exceed -2.2 dB
  - Max. reflection coefficient shall not exceed -2.2 dB
- To provide ACC and EBA functionality (Entry: 170km/h, Premium: 200km/h)
  - One-way attenuation shall not exceed 2dB

1.8 Sensor Vehicle Fixation

The customer shall fulfill a set of requirements with regard to assembly and secondary surface structure properties to ensure maximum sensor performance.

The ARS404 and ARS 408 sensor provides fixed screwing points for mounting to a metal frame.

Sensor unit fixation to the vehicle shall not create deformation of housing. The locking torque shall not exceed 7 Nm.

The sensor mounting interface elements (e.g. screws) shall be released to fulfill mechanical and electro-chemical (e.g. contact voltage) matching.

1.9 Additional information

Please contact your supplier if you are not sure how to correctly install or set up the ARS 40X during assembly with regard to aspects that are covered inadequately, or not all, in this operating manual.

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