C63®

ANSI-ASC-C63® Interpretation Request Form

This form shall be used for submission of Interpretation Requests related to ANSI-IEEE standards that are within the responsibility of ANSI-ASC-C63®. The eight parts of the form must be filled out completely, with the exception of the Subcommittee Response, to ensure expedient processing. This completed form is to be submitted to the Secretary of ANSI-ASC-C63® via e-mail.

Submission Date	Originator Name, Company
05/07/2016	Charles Wang / Champro Technology Co., Ltd.

Standard	Clause/ Sub clause	Paragraph Figure/ Table	Type (General/ Technical/ Editorial)	Comment / Inquiry	Subcommittee Response (to be filled in by Subcommittee Chair)
C63.4-2014	4.5 Antenna	Table 2	Technical	[f] The aperture dimensions of these horn antennas shall be small enough so that the measurement distance (in m) is equal to or greater than the Rayleigh (far-field) distance (i.e., $Rm = 2D^2 /\lambda$), where D is the largest dimension of the antenna aperture (in m) and is the free-space wavelength (in m) at the frequency of measurement. As the statement above, does it mean the different aperture of horn antennas need to be changed if the test distance is fixed at 3m for 1 to 18GHz for meet far field condition? For example Schwarzbeck 9120D with aperture 0.2832m, the test distance at 3 meter then it only applicable up to 6GHz? And we need to change another aperture antenna for above 6GHz? See the attached files.	Based on the information and considerations below, the cited footnote f of ANSI C63.4-2014, as well as the same text in the first sentence of the second paragraph of 4.5.5 therein, is not intended to preclude the use of double-ridge waveguide horns (such as Schwarzbeck 9120D) for 3 m product emission measurements in the frequency range 1 GHz to 18 GHz. Please note also that per the *Operating Procedures for Accredited Standards Committee C63®—Electromagnetic Compatibility (EMC)* (June 21, 2016) (available at the ASC C63® website), interpretations such as this may provide: "**meaning or clarification** to a portion of a standard when it … appears to be contradicted in normative references or other clauses in the standard." In addition, per the *Operating Procedures*: "[a]mendments or revisions to published standards are not made via an interpretation …". At the 11 May 2017 meeting of ASC C63®, the committee voted to include the change in the measurement distance to $D^2/2\lambda$ as part of the equation corrections in the approved C63.4a/D1.04 amendment to C63.4-2014. The amendment is due to be published shortly. ANSI C63.4a-2017 was published 13 Oct. 2017. As part of the open revision project, the amendment also will automatically be included in the full revision of C63.4-2014. Thus this issue will be resolved by C63.4a and in the full revision of C63.4-2014. See the discussion below for additional supporting information.

ANSI C63.5 (latest edition) is listed as a normative reference in Clause 2 of ANSI C63.4-2014, and therefore it is considered in the following discussion for the response to this interpretation request.

Subclause 5.1.3.1 of ANSI C63.5-2017 states:

a) 1) Calibration measurement antenna separation distance *R*:

> i) No calibrations shall be performed at distances with $R < 0.62\sqrt{D^3/\lambda}$.
>
> ii) AFs measured at distances with $0.62\sqrt{D^3/\lambda} \le R < 2D^2/\lambda$ shall be deemed acceptable at the calibrated distance.
>
> iii) AFs measured at distances with $R \ge 2D^2/\lambda$ shall be deemed acceptable at the calibrated distance and greater.
>
> iv) In the preceding items, *R* is the separation distance, *D* is the largest linear dimension (e.g., width or height) of the aperture of the antenna (per IEEE Std 149-1979, Annex A), and λ is the wavelength at the frequency being considered, all in meters.

Therefore, horn antenna factors are valid ONLY for the calibrated distance, unless (1) the far field requirement of distance $R \ge 2D^2 / \lambda$ is met, and (2) the antenna is not calibrated at a distance less than R = $0.62\sqrt{D^3/\lambda}$.

So, for the Schwarzbeck 9120D antenna with aperture (mouth) dimensions L = 0.245 m and W = 0.142 m, the aperture diagonal D = 0.2832 m, $D^2 = 0.0802\ m^2$. Note that use of the aperture diagonal for these range length considerations is consistent with for example the popular textbook by Balanis,[1] whereas ANSI C63.5-2017 5.1.3.1 a) iv) considers D as the "largest linear dimension (e.g., width or height)" (i.e., consistent with Annex A of IEEE Std 149-1979). For convenience, the table below shows parameters based on both the aperture diagonal and the aperture largest linear dimension (length L = 0.245 m, $L^2 = 0.06\ m^2$).

Per the preceding ANSI C63.5-2017 provisions, the Schwarzbeck 9120D antenna can be calibrated at a 3 m distance from 1−18 GHz, and therefore can be used for emission measurements at 3 m from 1−18 GHz. From 1−5.9 GHz, the distance is greater than $2D^2/\lambda$, so it satisfies the far-field condition, and can be used for any far-field measurements. Between 5.9 GHz and 18 GHz, the distance is greater than $0.62\sqrt{D^3/\lambda}$ as required by ANSI C63.5-2017, but shorter than $2D^2/\lambda$, so it is only valid for the specific calibration distance, which in this case is 3 m.

f, GHz	**λ, m**	**$0.62\sqrt{(D^3/\lambda)}$**	**D^2/λ**	**$0.5\ D^2/\lambda$**	**$2\ D^2/\lambda$**	**$0.62\sqrt{(L^3/\lambda)}$**	**L^2/λ**	**$0.5\ L^2/\lambda$**	**$2\ L^2/\lambda$**
1	0.3	0.17	0.267	0.134	0.534	0.14	0.2	0.1	0.4
6	0.05	0.42	1.604	0.802	3.208	0.34	1.2	0.6	2.4
12	0.025	0.59	3.208	1.604	6.416	0.48	2.4	1.2	4.8
18	0.016	0.72	4.812	2.406	9.624	0.58	3.6	1.8	7.2

Concerning the term "Rayleigh distance" used in ANSI C63.4-2014, in preparing this interpretation an authoritative and uniformly applied definition was not found in a relatively extensive survey of literature at the ieeexplore website and in numerous electromagnetics and antennas textbooks. Since about the 1950s and through today, different publications have used "Rayleigh distance" to refer to either $2D^2/\lambda$ or $D^2/2\lambda$.

[1] Balanis, C.A., Antenna Theory: Analysis and Design, 4th Edition, 2016, pg. 161.

As originally inserted in the 1992 edition of ANSI C63.4-1992, the convention $Rm = D^2/2\lambda$ was actually used for Rayleigh distance, further to its use in a 1967 NBS report.[2] As shown in the table above, typical 1−18 GHz double-ridged horns readily meet the original $D^2/2\lambda$ requirement. It is notable that CISPR 16-1-4 also specifies the $D^2/2\lambda$ spacing for horn antennas; e.g., 4.6 in Ed 3.1 of that document.

The 2003 revision of ANSI C63.4 changed the equation for Rayleigh distance to $Rm = 2D^2/\lambda$, as well as changed the term to “Rayleigh (far-field) distance.” Although relevant working group records were not available while preparing this interpretation, presumably the change was due to popular use of the latter as the Fresnel-Fraunhofer boundary far-field distance criterion, for example as in antenna textbooks of this generation such as Balanis, Kraus, and Stutzman and Thiele.

As stated earlier in this document, this interpretation is being provided to the relevant ASC C63® SC1 working group, to serve as a request for the matter to be considered for change in the next revision of ANSI C63.4.

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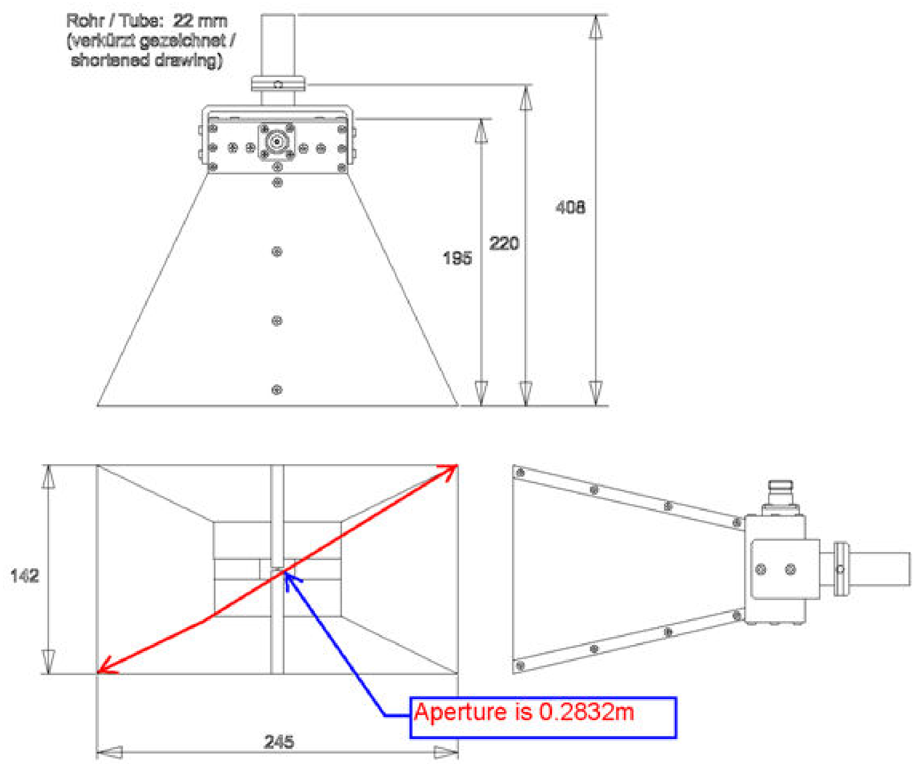
[2] Beatty, R.W., Discussion of Errors in Gain Measurements of Standard Electromagnetic Horns, NBS Technical Note 351, March 1967, (http://nvlpubs.nist.gov/nistpubs/Legacy/TN/nbstechnicalnote351.pdf).

ATTACHMENT 1 OF 2 TO ORIGINAL INTERPRETATION REQUEST:

SCHWARZBECK MESS - ELEKTRONIK

An der Klinge 29 D-69250 Schönau Tel.: 06228/1001 Fax.: (49)6228/1003

Doppelsteg Breitband Hornantenne BBHA 9120 D
Double Ridged Broadband Horn BBHA 9120 D



Frequenz / *Frequency:*	**1 - 18 GHz**
Gewinn / *Gain:*	**6.3 - 18 dBi**
Wandlungsmaß / *Antenna factor:*	**24 - 41.8 dB/m**
VSWR typ.:	**< 2**
Maße / *Dimensions* (B x H x T) :	**245 x 142 x 408 mm**
22 mm Rohr / 22 mm *Tube:*	**22 x 200 mm**
Gewicht / *Weight:*	**1.3 kg**
Max. Eingangsleistung / *Max. Input Power:*	**Begrenzt nur durch Steckverbinder / *Limited only by N-connector***
Anschluß / *Connector:*	**N-Buchse / *N-female***
Material:	**Aluminium**

ATTACHMENT 2 OF 2 TO ORIGINAL INTERPRETATION REQUEST:

F(MHz)	λ(m)	2π	Phase Dev.(°)	ΔR	ΔR'	Fix D D(m)	R(m)	R+ΔR	Farthest R(m)
1000	0.3	360	22.5	0.01875	0.018115	0.2832	0.5346816	0.5534316	0.5159316
2000	0.15	360	22.5	0.009375	0.009294	0.2832	1.0693632	1.0787382	1.0599882
3000	0.1	360	22.5	0.00625	0.006226	0.2832	1.6040448	1.6102948	1.5977948
4000	0.075	360	22.5	0.004688	0.004677	0.2832	2.1387264	2.1434139	2.1340389
5000	0.06	360	22.5	0.00375	0.003745	0.2832	2.673408	2.677158	2.669658
6000	0.05	360	22.5	0.003125	0.003122	0.2832	3.2080896	3.2112146	3.2049646
7000	0.04285714	360	22.5	0.002679	0.002677	0.2832	3.7427712	3.74544977	3.740092629
8000	0.0375	360	22.5	0.002344	0.002342	0.2832	4.2774528	4.27979655	4.27510905
9000	0.03333333	360	22.5	0.002083	0.002082	0.2832	4.8121344	4.81421773	4.810051067
10000	0.03	360	22.5	0.001875	0.001874	0.2832	5.346816	5.348691	5.344941
11000	0.02727273	360	22.5	0.001705	0.001704	0.2832	5.8814976	5.88320215	5.879793055
12000	0.025	360	22.5	0.001563	0.001562	0.2832	6.4161792	6.4177417	6.4146167
13000	0.02307692	360	22.5	0.001442	0.001442	0.2832	6.9508608	6.95230311	6.949418492
14000	0.02142857	360	22.5	0.001339	0.001339	0.2832	7.4855424	7.48688169	7.484203114
15000	0.02	360	22.5	0.00125	0.00125	0.2832	8.020224	8.021474	8.018974
16000	0.01875	360	22.5	0.001172	0.001172	0.2832	8.5549056	8.55607748	8.553733725
17000	0.01764706	360	22.5	0.001103	0.001103	0.2832	9.0895872	9.09069014	9.088484259
18000	0.01666667	360	22.5	0.001042	0.001042	0.2832	9.6242688	9.62531047	9.623227133

formulas:

F(MHz)	λ(m)	2π	Phase Dev.(°)	ΔR	ΔR'	Fix D D(m)	R(m)	R+ΔR	Farthest R(m)
1000	=(3*10^8)/(A4*10^6)	360	22.5	=G4^2/(8*H4)	=G4^2/(8*I4)	0.2832	=C4*G4^2/(8*B4*D4)	=H4+E4	=H4-E4
=A4+1000	=(3*10^8)/(A5*10^6)	360	22.5	=G5^2/(8*H5)	=G5^2/(8*I5)	=G4	=C5*G5^2/(8*B5*D5)	=H5+E5	=H5-E5
=A5+1000	=(3*10^8)/(A6*10^6)	360	22.5	=G6^2/(8*H6)	=G6^2/(8*I6)	=G5	=C6*G6^2/(8*B6*D6)	=H6+E6	=H6-E6
=A6+1000	=(3*10^8)/(A7*10^6)	360	22.5	=G7^2/(8*H7)	=G7^2/(8*I7)	=G6	=C7*G7^2/(8*B7*D7)	=H7+E7	=H7-E7
=A7+1000	=(3*10^8)/(A8*10^6)	360	22.5	=G8^2/(8*H8)	=G8^2/(8*I8)	=G7	=C8*G8^2/(8*B8*D8)	=H8+E8	=H8-E8
=A8+1000	=(3*10^8)/(A9*10^6)	360	22.5	=G9^2/(8*H9)	=G9^2/(8*I9)	=G8	=C9*G9^2/(8*B9*D9)	=H9+E9	=H9-E9
=A9+1000	=(3*10^8)/(A10*10^6)	360	22.5	=G10^2/(8*H10)	=G10^2/(8*I10)	=G9	=C10*G10^2/(8*B10*D10)	=H10+E10	=H10-E10
=A10+1000	=(3*10^8)/(A11*10^6)	360	22.5	=G11^2/(8*H11)	=G11^2/(8*I11)	=G10	=C11*G11^2/(8*B11*D11)	=H11+E11	=H11-E11
=A11+1000	=(3*10^8)/(A12*10^6)	360	22.5	=G12^2/(8*H12)	=G12^2/(8*I12)	=G11	=C12*G12^2/(8*B12*D12)	=H12+E12	=H12-E12
=A12+1000	=(3*10^8)/(A13*10^6)	360	22.5	=G13^2/(8*H13)	=G13^2/(8*I13)	=G12	=C13*G13^2/(8*B13*D13)	=H13+E13	=H13-E13
=A13+1000	=(3*10^8)/(A14*10^6)	360	22.5	=G14^2/(8*H14)	=G14^2/(8*I14)	=G12	=C14*G14^2/(8*B14*D14)	=H14+E14	=H14-E14
=A14+1000	=(3*10^8)/(A15*10^6)	360	22.5	=G15^2/(8*H15)	=G15^2/(8*I15)	=G13	=C15*G15^2/(8*B15*D15)	=H15+E15	=H15-E15
=A15+1000	=(3*10^8)/(A16*10^6)	360	22.5	=G16^2/(8*H16)	=G16^2/(8*I16)	=G15	=C16*G16^2/(8*B16*D16)	=H16+E16	=H16-E16
=A16+1000	=(3*10^8)/(A17*10^6)	360	22.5	=G17^2/(8*H17)	=G17^2/(8*I17)	=G16	=C17*G17^2/(8*B17*D17)	=H17+E17	=H17-E17
=A17+1000	=(3*10^8)/(A18*10^6)	360	22.5	=G18^2/(8*H18)	=G18^2/(8*I18)	=G17	=C18*G18^2/(8*B18*D18)	=H18+E18	=H18-E18
=A18+1000	=(3*10^8)/(A19*10^6)	360	22.5	=G19^2/(8*H19)	=G19^2/(8*I19)	=G18	=C19*G19^2/(8*B19*D19)	=H19+E19	=H19-E19
=A19+1000	=(3*10^8)/(A20*10^6)	360	22.5	=G20^2/(8*H20)	=G20^2/(8*I20)	=G19	=C20*G20^2/(8*B20*D20)	=H20+E20	=H20-E20
=A20+1000	=(3*10^8)/(A21*10^6)	360	22.5	=G21^2/(8*H21)	=G21^2/(8*I21)	=G20	=C21*G21^2/(8*B21*D21)	=H21+E21	=H21-E21