

Calibration certificates RISE equipment used for test report P114425-F30

	Serial number on equipment	RISE number	File name/ Page number
R&S FSW 43	100 560	902 073	902 073 - FSW43.pdf
R&S ESU 26	100 409	901 553	901 553 - ESU26.pdf
R&S ZNB 40	101 544	BX50051	BX50051 - ZNB40.pdf
Mixer FS-Z60	100 996	BX90566	BX90566 R&S Mixer FS-Z60.pdf
Mixer FS-Z90	101 871	BX90567	BX90567 R&S Mixer FS-Z90.pdf
Mixer FS-Z110	101 467	BX81425	BX81425 R&S Mixer FS-Z110.pdf
Mixer FS-Z170	100974	BX81426	BX81426 R&S Mixer FS-Z170.pdf
Mixer FS-Z220	100967	BX81427	BX81427 R&S Mixer FS-Z220.pdf
EMCO Horn Antenna 3116	9904-2426	503 279	503279-3116 Certificate.pdf
Bilog antenna Schaffner 6143A	23 169	504 079	2 – 8
EMCO Horn Antenna 3115	9509-4562	502 175	9 – 16
EMCO Horn Antenna 3115	00143 161	902 212	17 – 24
Flann STD Gain Horn Antenna 20240-20	Manufacturer provided gain 275170	KWP02600	25
Flann STD Gain Horn Antenna 22240-20	Manufacturer provided gain 274184	KWP02601	26
Flann STD Gain Horn Antenna 24240-20	Manufacturer provided gain 141	BX92414	27
Flann STD Gain Horn Antenna 26240-20	Manufacturer provided gain 124 440	BX92416	28
Flann STD Gain Horn Antenna 27240-20	Manufacturer provided gain 281	BX92417	29
Flann STD Gain Horn Antenna 29240-20	Manufacturer provided gain 46	BX92419	30
Flann STD Gain Horn Antenna 30240-20	Manufacturer provided gain 29	BX92420	31

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Reference
105503-I10047-K262

Page
1 (7)

ELx

Calibration of antenna CBL 6143A

Identification

Object Hybrid antenna CBL 6143A, s/n 23169
Object state Upon arrival the object had no visual damage.
Calibration location Borås, Sweden
Calibration date 2021-07-02 & 2021-07-14

Calibration Procedure

The antenna is calibrated according to standard ANSI C63.5 (2017). The antenna was calibrated on an open area test site according to SP method 4429 in the frequency range 30-1000 MHz. A calibration in a full anechoic chamber according to SP-method 5594 was used above 1000 Mhz.

Measurement conditions

Control room (Maxwell)

Temperature 22 ± 1 °C
Relative humidity $62 \%RH \pm 10 \%$

Open area test site (Maxwell)

Temperature 26 ± 1 °C
Relative humidity $68 \%RH \pm 10 \%$

Fully anechoic chamber (Hertz)

Temperature 22 ± 1 °C
Relative humidity $33 \%RH \pm 10 \%$

Traceability

The calibration was carried out using equipment with calibrations traceable to national standards.

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Results

The reported expanded uncertainty of measurement is stated as the standard uncertainty of the calibration multiplied by the coverage factor k . For scalar measurands, $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty has been determined in accordance with EA Publication EA-4/02. The long term stability of the calibrated object is not included in the reported expanded uncertainty of measurement.

Expanded uncertainty (Antenna Factor or Gain): ± 1.0 dB

Antenna factors and gain

The calibrated antenna factor / gain is provided in the tables and figures attached to this certificate. The reflection coefficient is provided as a courtesy. It should only be considered as a functionality check of the antenna and is not regarded as calibration data.

Type	Figure	Table
Antenna Factor (30MHz - 3 GHz)	1	1
Antenna Gain (30MHz - 3 GHz)	2	2
Reflection coefficient	3	
Symmetry check (30-300 MHz)	4	

Table 1: Antenna Factor.

F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]
30	22.95	280	12.94	530	17.49	780	20.01	1300	22.95		
35	20.49	285	12.85	535	17.66	785	20.26	1350	23.38		
40	17.83	290	12.88	540	18.19	790	20.34	1400	23.35		
45	15.28	295	13.06	545	18.67	795	20.16	1450	24.19		
50	13.10	300	13.55	550	18.86	800	20.10	1500	24.00		
55	11.45	305	14.00	555	18.77	805	20.00	1550	24.27		
60	10.35	310	14.07	560	18.69	810	20.00	1600	24.46		
65	9.51	315	14.04	565	18.78	815	19.98	1650	25.08		
70	8.81	320	13.97	570	18.80	820	20.09	1700	25.04		
75	8.08	325	13.90	575	18.79	825	20.10	1750	25.35		
80	7.55	330	13.80	580	18.80	830	20.11	1800	25.25		
85	7.60	335	13.84	585	18.75	835	20.27	1850	25.62		
90	8.27	340	13.93	590	18.71	840	20.38	1900	26.38		
95	9.26	345	14.12	595	18.76	845	20.47	1950	26.35		
100	10.44	350	14.33	600	18.72	850	20.51	2000	26.67		
105	11.41	355	14.46	605	18.68	855	20.52	2050	26.80		
110	12.15	360	14.58	610	18.70	860	20.59	2100	26.81		
115	12.64	365	14.71	615	18.81	865	20.63	2150	27.10		
120	12.92	370	14.85	620	18.95	870	20.66	2200	28.14		
125	12.97	375	14.98	625	19.00	875	20.77	2250	28.25		
130	12.95	380	15.11	630	18.92	880	20.97	2300	27.91		
135	12.79	385	15.28	635	18.86	885	20.84	2350	28.52		
140	12.56	390	15.55	640	18.98	890	20.66	2400	28.68		
145	12.13	395	15.86	645	19.15	895	20.63	2450	28.70		
150	11.67	400	16.29	650	19.14	900	20.63	2500	29.29		
155	11.25	405	16.56	655	19.07	905	20.65	2550	30.59		
160	10.91	410	16.44	660	19.01	910	20.70	2600	30.86		
165	10.71	415	16.22	665	18.95	915	20.77	2650	30.36		
170	10.57	420	16.16	670	18.88	920	20.81	2700	30.50		
175	10.45	425	16.09	675	18.91	925	20.87	2750	31.04		
180	10.37	430	16.11	680	18.92	930	20.94	2800	31.36		
185	10.47	435	16.18	685	18.94	935	20.99	2850	32.29		
190	10.71	440	16.27	690	19.00	940	21.01	2900	32.43		
195	11.08	445	16.40	695	18.98	945	21.00	2950	31.38		
200	11.41	450	16.54	700	18.96	950	21.04	3000	31.88		
205	11.64	455	16.61	705	19.00	955	21.13				
210	11.82	460	16.75	710	19.09	960	21.29				
215	12.09	465	16.93	715	19.26	965	21.38				
220	12.42	470	17.04	720	19.40	970	21.46				
225	12.09	475	17.16	725	19.44	975	21.54				
230	11.68	480	17.24	730	19.47	980	21.57				
235	11.83	485	17.16	735	19.56	985	21.58				
240	12.11	490	17.22	740	19.63	990	21.62				
245	12.46	495	17.33	745	19.67	995	21.65				
250	12.66	500	17.34	750	19.72	1000	21.69				
255	12.73	505	17.38	755	19.80	1050	21.18				
260	12.78	510	17.37	760	19.87	1100	21.55				
265	12.88	515	17.35	765	19.89	1150	21.38				
270	13.06	520	17.37	770	19.91	1200	22.21				
275	12.98	525	17.36	775	19.93	1250	22.55				

Table 2: Antenna Gain.

F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]
30	-23.19	280	6.22	530	7.21	780	8.04	1300	9.54		
35	-19.40	285	6.46	535	7.12	785	7.85	1350	9.43		
40	-15.58	290	6.58	540	6.67	790	7.82	1400	9.78		
45	-12.00	295	6.55	545	6.26	795	8.05	1450	9.24		
50	-8.91	300	6.21	550	6.16	800	8.17	1500	9.73		
55	-6.43	305	5.90	555	6.32	805	8.32	1550	9.74		
60	-4.57	310	5.97	560	6.48	810	8.38	1600	9.83		
65	-3.04	315	6.14	565	6.47	815	8.45	1650	9.48		
70	-1.69	320	6.34	570	6.53	820	8.40	1700	9.78		
75	-0.37	325	6.55	575	6.62	825	8.44	1750	9.72		
80	0.72	330	6.78	580	6.68	830	8.48	1800	10.06		
85	1.20	335	6.87	585	6.80	835	8.38	1850	9.94		
90	1.02	340	6.91	590	6.92	840	8.32	1900	9.41		
95	0.50	345	6.85	595	6.94	845	8.27	1950	9.66		
100	-0.23	350	6.76	600	7.06	850	8.29	2000	9.56		
105	-0.78	355	6.75	605	7.17	855	8.33	2050	9.65		
110	-1.11	360	6.76	610	7.22	860	8.31	2100	9.84		
115	-1.22	365	6.74	615	7.18	865	8.32	2150	9.75		
120	-1.13	370	6.73	620	7.10	870	8.34	2200	8.92		
125	-0.82	375	6.71	625	7.13	875	8.28	2250	9.00		
130	-0.46	380	6.70	630	7.28	880	8.13	2300	9.53		
135	0.02	385	6.64	635	7.41	885	8.31	2350	9.11		
140	0.58	390	6.49	640	7.36	890	8.54	2400	9.14		
145	1.30	395	6.28	645	7.26	895	8.62	2450	9.29		
150	2.06	400	5.96	650	7.33	900	8.67	2500	8.87		
155	2.77	405	5.80	655	7.46	905	8.70	2550	7.75		
160	3.38	410	6.03	660	7.59	910	8.70	2600	7.65		
165	3.85	415	6.35	665	7.71	915	8.67	2650	8.32		
170	4.24	420	6.51	670	7.85	920	8.67	2700	8.34		
175	4.62	425	6.68	675	7.89	925	8.66	2750	7.95		
180	4.95	430	6.77	680	7.94	930	8.64	2800	7.79		
185	5.08	435	6.80	685	7.99	935	8.63	2850	7.02		
190	5.08	440	6.81	690	7.99	940	8.66	2900	7.03		
195	4.93	445	6.78	695	8.07	945	8.72	2950	8.22		
200	4.82	450	6.73	700	8.15	950	8.73	3000	7.87		
205	4.81	455	6.76	705	8.18	955	8.68				
210	4.84	460	6.72	710	8.15	960	8.57				
215	4.77	465	6.63	715	8.04	965	8.52				
220	4.64	470	6.61	720	7.96	970	8.49				
225	5.17	475	6.58	725	7.98	975	8.45				
230	5.76	480	6.60	730	8.00	980	8.47				
235	5.80	485	6.76	735	7.97	985	8.50				
240	5.70	490	6.80	740	7.97	990	8.50				
245	5.53	495	6.77	745	7.98	995	8.52				
250	5.51	500	6.85	750	7.99	1000	8.52				
255	5.61	505	6.90	755	7.97	1050	9.45				
260	5.73	510	6.99	760	7.96	1100	9.49				
265	5.80	515	7.09	765	7.99	1150	10.04				
270	5.78	520	7.16	770	8.03	1200	9.59				
275	6.01	525	7.26	775	8.06	1250	9.60				

Figure 1: Antenna Factor

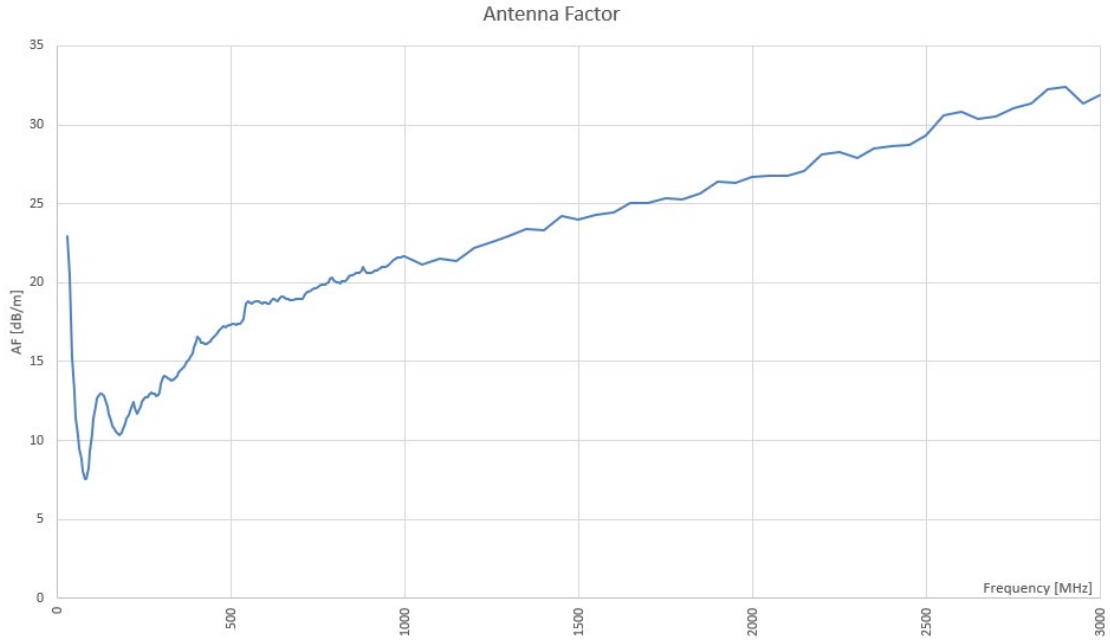


Figure 2: Antenna Gain

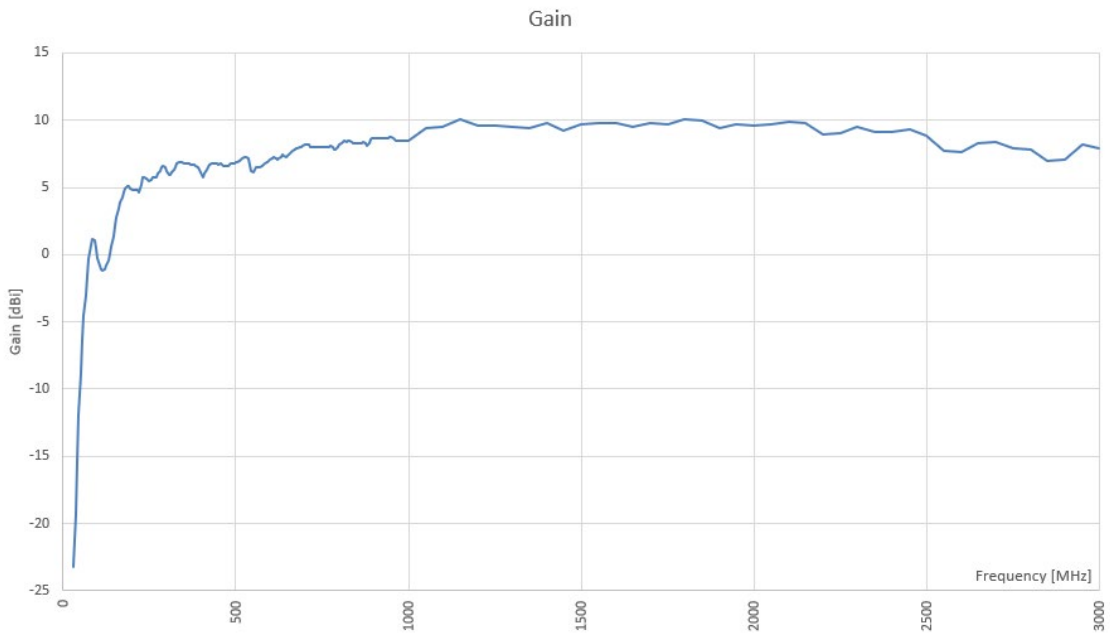


Figure 3: Reflection coefficient

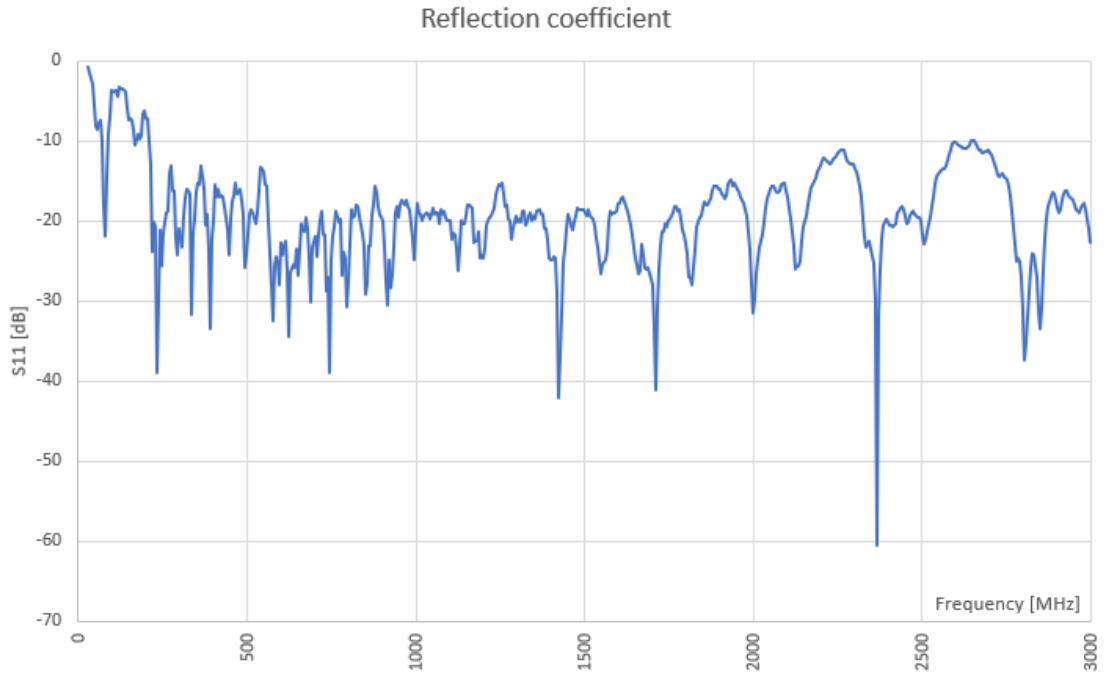
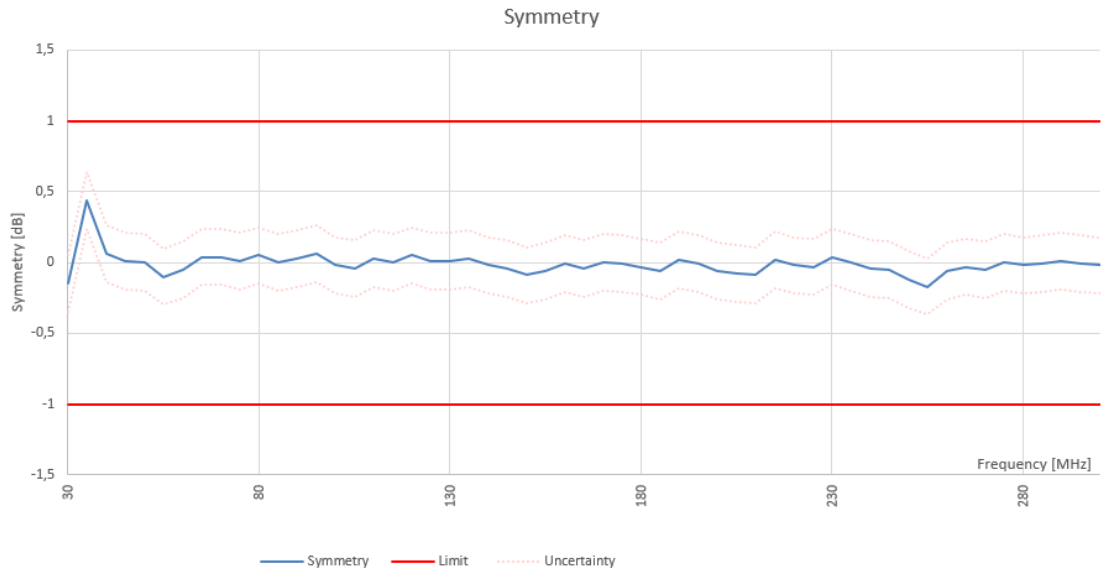


Figure 4: Symmetry check



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Page
1 (8)

RISE

Calibration of EMCO 3115

Identification

Object EMCO 3115, Serial no. 9509-4562
Object state Upon arrival the object had no visual damage.
Location Borås, Sweden
Date 2021-07-02

Procedure

The calibration was carried out in an anechoic chamber, using equipment with calibrations traceable to national standards. The calibration was carried out according to RISE method 5594, which is the implementation of ANSI C63.5 (2017).

Measurement conditions

Hertz

Temperature 21 ± 1 °C
Relative humidity $62 \%RH \pm 10 \%$

Test Equipment

Measurement equipment	RISE inventory number
Network Analyzer R&S ZNB20	902 290
Temperature and Humidity Meter Testo 615	502 658

Traceability

The network analyzer was calibrated traceable to recognized standards laboratories.

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Results

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k . For scalar measurands, $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty has been determined in accordance with EA Publication EA-4/02. The long term stability of the calibrated object is not included in the reported expanded uncertainty of measurement.

Expanded uncertainty (Antenna Factor or Gain): ± 1.0 dB

Antenna factors and gain

The measured antenna factor / gain is provided in the tables and figures attached to this certificate. The reflection coefficient is provided as a courtesy. It should only be considered as a functionality check of the antenna and is not regarded as calibration data.

Type	Distance	Polarisation	Figure	Table
Antenna Gain (1-18 GHz)	3 m	horizontal	1	1
Antenna Factor (1-18 GHz)	3 m	horizontal	2	2
Reflection Coefficient			3	

Table 1: Antenna Gain.

F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]
1000	5.86	3500	10.03	6000	11.42	8500	11.44	11000	12.16
1050	6.15	3550	10.18	6050	11.46	8550	11.40	11050	12.29
1100	6.48	3600	10.20	6100	11.48	8600	11.36	11100	12.25
1150	6.21	3650	10.11	6150	11.46	8650	11.35	11150	12.30
1200	6.66	3700	9.78	6200	11.59	8700	11.40	11200	12.27
1250	6.68	3750	9.52	6250	11.69	8750	11.32	11250	12.25
1300	7.13	3800	9.53	6300	11.78	8800	11.35	11300	12.34
1350	7.49	3850	9.56	6350	11.85	8850	11.31	11350	12.37
1400	7.62	3900	9.50	6400	11.96	8900	11.30	11400	12.39
1450	8.04	3950	9.63	6450	12.11	8950	11.46	11450	12.40
1500	8.17	4000	9.84	6500	12.32	9000	11.53	11500	12.33
1550	8.58	4050	10.17	6550	12.32	9050	11.58	11550	12.29
1600	8.90	4100	10.35	6600	12.21	9100	11.48	11600	12.13
1650	9.01	4150	10.45	6650	12.02	9150	11.48	11650	12.10
1700	8.95	4200	10.62	6700	11.74	9200	11.47	11700	11.94
1750	8.16	4250	10.82	6750	11.73	9250	11.53	11750	11.90
1800	8.59	4300	10.88	6800	11.75	9300	11.44	11800	11.84
1850	8.37	4350	10.90	6850	11.73	9350	11.41	11850	11.83
1900	8.07	4400	10.92	6900	11.76	9400	11.33	11900	11.87
1950	8.52	4450	10.90	6950	11.85	9450	11.27	11950	11.95
2000	8.77	4500	11.01	7000	11.83	9500	11.29	12000	12.15
2050	8.80	4550	11.02	7050	11.86	9550	11.42	12050	12.34
2100	8.85	4600	11.12	7100	11.83	9600	11.48	12100	12.49
2150	8.95	4650	11.07	7150	11.75	9650	11.38	12150	12.70
2200	9.45	4700	11.00	7200	11.57	9700	11.27	12200	12.74
2250	9.64	4750	10.91	7250	11.35	9750	11.12	12250	12.98
2300	9.70	4800	10.86	7300	11.18	9800	10.93	12300	13.08
2350	9.38	4850	10.81	7350	11.17	9850	10.93	12350	13.14
2400	9.33	4900	10.95	7400	11.15	9900	10.76	12400	13.25
2450	9.73	4950	10.96	7450	11.24	9950	10.69	12450	13.26
2500	9.79	5000	10.90	7500	11.31	10000	10.58	12500	13.36
2550	9.86	5050	10.65	7550	11.41	10050	10.49	12550	13.41
2600	9.72	5100	10.75	7600	11.48	10100	10.50	12600	13.45
2650	9.64	5150	10.69	7650	11.65	10150	10.57	12650	13.43
2700	9.90	5200	10.66	7700	11.63	10200	10.52	12700	13.37
2750	10.10	5250	10.76	7750	11.68	10250	10.54	12750	13.30
2800	10.07	5300	10.79	7800	11.74	10300	10.50	12800	13.31
2850	10.17	5350	10.85	7850	11.71	10350	10.55	12850	13.27
2900	10.25	5400	10.83	7900	11.69	10400	10.69	12900	13.35
2950	10.05	5450	10.78	7950	11.60	10450	10.82	12950	13.25
3000	9.85	5500	10.65	8000	11.56	10500	10.87	13000	13.31
3050	9.73	5550	10.67	8050	11.60	10550	10.95	13050	13.13
3100	9.70	5600	10.89	8100	11.62	10600	11.11	13100	13.19
3150	9.62	5650	11.11	8150	11.61	10650	11.23	13150	13.09
3200	9.64	5700	11.30	8200	11.69	10700	11.42	13200	12.98
3250	9.64	5750	11.35	8250	11.69	10750	11.57	13250	12.86
3300	9.69	5800	11.43	8300	11.61	10800	11.69	13300	12.75
3350	9.68	5850	11.39	8350	11.57	10850	11.82	13350	12.65
3400	9.77	5900	11.42	8400	11.52	10900	12.02	13400	12.57
3450	9.89	5950	11.45	8450	11.45	10950	12.11	13450	12.46

F [MHz]	G [dBi]	F [MHz]	G [dBi]
13500	12.37	16000	16.54
13550	12.27	16050	16.48
13600	12.23	16100	16.56
13650	12.23	16150	16.51
13700	12.28	16200	16.54
13750	12.23	16250	16.58
13800	12.16	16300	16.50
13850	12.01	16350	16.59
13900	11.83	16400	16.32
13950	11.82	16450	16.43
14000	11.58	16500	16.17
14050	11.52	16550	16.21
14100	11.31	16600	15.96
14150	11.17	16650	15.99
14200	11.04	16700	15.71
14250	10.99	16750	15.67
14300	10.79	16800	15.39
14350	10.80	16850	15.30
14400	10.67	16900	15.02
14450	10.72	16950	14.78
14500	10.60	17000	14.54
14550	10.58	17050	14.14
14600	10.46	17100	14.05
14650	10.49	17150	13.62
14700	10.69	17200	13.49
14750	10.92	17250	12.98
14800	11.31	17300	12.81
14850	11.47	17350	12.23
14900	11.68	17400	11.95
14950	12.05	17450	11.31
15000	12.38	17500	10.76
15050	12.85	17550	10.10
15100	13.18	17600	9.49
15150	13.50	17650	8.86
15200	13.83	17700	8.19
15250	14.22	17750	7.68
15300	14.64	17800	7.20
15350	14.91	17850	7.22
15400	15.19	17900	7.03
15450	15.37	17950	7.28
15500	15.67	18000	7.19
15550	15.81		
15600	16.02		
15650	16.02		
15700	16.19		
15750	16.17		
15800	16.36		
15850	16.27		
15900	16.46		
15950	16.34		

Table 2: Antenna Factor.

F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]
1000	24.35	3500	31.06	6000	34.35	8500	37.36	11000	38.87
1050	24.48	3550	31.03	6050	34.39	8550	37.45	11050	38.79
1100	24.56	3600	31.14	6100	34.44	8600	37.54	11100	38.87
1150	25.21	3650	31.34	6150	34.53	8650	37.60	11150	38.86
1200	25.14	3700	31.80	6200	34.47	8700	37.60	11200	38.92
1250	25.47	3750	32.17	6250	34.44	8750	37.73	11250	38.98
1300	25.36	3800	32.28	6300	34.42	8800	37.75	11300	38.93
1350	25.33	3850	32.36	6350	34.41	8850	37.84	11350	38.94
1400	25.51	3900	32.54	6400	34.37	8900	37.90	11400	38.96
1450	25.40	3950	32.51	6450	34.29	8950	37.78	11450	38.99
1500	25.56	4000	32.41	6500	34.15	9000	37.77	11500	39.09
1550	25.43	4050	32.19	6550	34.21	9050	37.76	11550	39.17
1600	25.39	4100	32.12	6600	34.39	9100	37.91	11600	39.37
1650	25.55	4150	32.12	6650	34.65	9150	37.96	11650	39.44
1700	25.87	4200	32.05	6700	34.99	9200	38.01	11700	39.64
1750	26.91	4250	31.96	6750	35.07	9250	38.00	11750	39.71
1800	26.72	4300	32.00	6800	35.11	9300	38.14	11800	39.81
1850	27.18	4350	32.08	6850	35.20	9350	38.22	11850	39.86
1900	27.72	4400	32.16	6900	35.23	9400	38.34	11900	39.85
1950	27.49	4450	32.28	6950	35.20	9450	38.45	11950	39.81
2000	27.46	4500	32.26	7000	35.28	9500	38.48	12000	39.64
2050	27.64	4550	32.35	7050	35.31	9550	38.39	12050	39.49
2100	27.81	4600	32.34	7100	35.41	9600	38.38	12100	39.38
2150	27.91	4650	32.49	7150	35.55	9650	38.52	12150	39.20
2200	27.60	4700	32.65	7200	35.79	9700	38.68	12200	39.19
2250	27.62	4750	32.84	7250	36.07	9750	38.87	12250	38.99
2300	27.75	4800	32.97	7300	36.30	9800	39.10	12300	38.92
2350	28.25	4850	33.11	7350	36.37	9850	39.15	12350	38.90
2400	28.48	4900	33.06	7400	36.45	9900	39.37	12400	38.83
2450	28.27	4950	33.14	7450	36.41	9950	39.48	12450	38.85
2500	28.38	5000	33.28	7500	36.40	10000	39.63	12500	38.79
2550	28.48	5050	33.63	7550	36.36	10050	39.76	12550	38.77
2600	28.79	5100	33.61	7600	36.34	10100	39.80	12600	38.76
2650	29.03	5150	33.76	7650	36.23	10150	39.77	12650	38.82
2700	28.93	5200	33.87	7700	36.31	10200	39.86	12700	38.92
2750	28.89	5250	33.85	7750	36.31	10250	39.89	12750	39.02
2800	29.08	5300	33.90	7800	36.31	10300	39.96	12800	39.04
2850	29.14	5350	33.92	7850	36.40	10350	39.96	12850	39.12
2900	29.21	5400	34.03	7900	36.47	10400	39.87	12900	39.07
2950	29.55	5450	34.16	7950	36.62	10450	39.77	12950	39.20
3000	29.90	5500	34.37	8000	36.71	10500	39.76	13000	39.18
3050	30.17	5550	34.43	8050	36.73	10550	39.73	13050	39.39
3100	30.34	5600	34.29	8100	36.76	10600	39.60	13100	39.37
3150	30.55	5650	34.14	8150	36.82	10650	39.52	13150	39.50
3200	30.67	5700	34.02	8200	36.80	10700	39.38	13200	39.64
3250	30.80	5750	34.05	8250	36.85	10750	39.27	13250	39.80
3300	30.89	5800	34.04	8300	36.98	10800	39.19	13300	39.94
3350	31.03	5850	34.16	8350	37.07	10850	39.10	13350	40.07
3400	31.07	5900	34.21	8400	37.17	10900	38.94	13400	40.18
3450	31.07	5950	34.25	8450	37.30	10950	38.89	13450	40.33

F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]
13500	40.45	16000	37.76
13550	40.58	16050	37.84
13600	40.65	16100	37.78
13650	40.68	16150	37.86
13700	40.66	16200	37.86
13750	40.75	16250	37.85
13800	40.85	16300	37.95
13850	41.03	16350	37.89
13900	41.24	16400	38.18
13950	41.28	16450	38.10
14000	41.55	16500	38.39
14050	41.65	16550	38.38
14100	41.89	16600	38.65
14150	42.06	16650	38.65
14200	42.21	16700	38.95
14250	42.29	16750	39.02
14300	42.52	16800	39.33
14350	42.55	16850	39.44
14400	42.70	16900	39.75
14450	42.69	16950	40.01
14500	42.84	17000	40.28
14550	42.89	17050	40.71
14600	43.04	17100	40.82
14650	43.03	17150	41.27
14700	42.87	17200	41.43
14750	42.66	17250	41.96
14800	42.31	17300	42.16
14850	42.18	17350	42.77
14900	41.99	17400	43.07
14950	41.66	17450	43.73
15000	41.36	17500	44.31
15050	40.91	17550	44.99
15100	40.61	17600	45.63
15150	40.32	17650	46.28
15200	40.02	17700	46.98
15250	39.66	17750	47.51
15300	39.27	17800	48.02
15350	39.02	17850	48.03
15400	38.77	17900	48.23
15450	38.62	17950	48.01
15500	38.35	18000	48.13
15550	38.23		
15600	38.06		
15650	38.08		
15700	37.94		
15750	37.98		
15800	37.83		
15850	37.94		
15900	37.77		
15950	37.92		

Figure 1: Antenna Gain.



Figure 2: Antenna Factor.

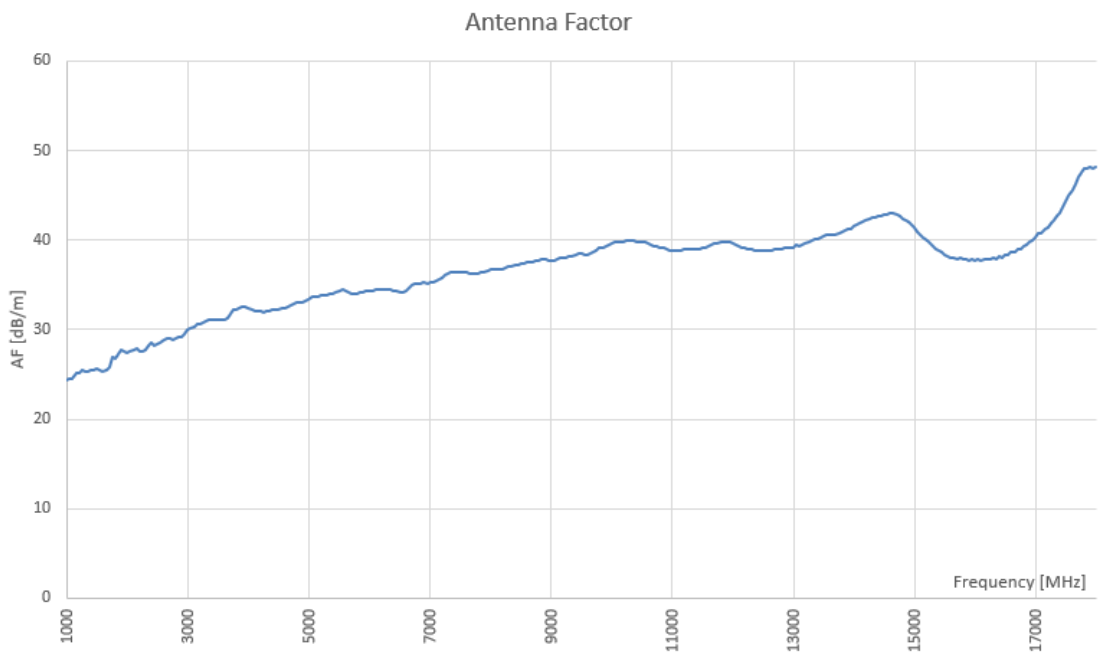
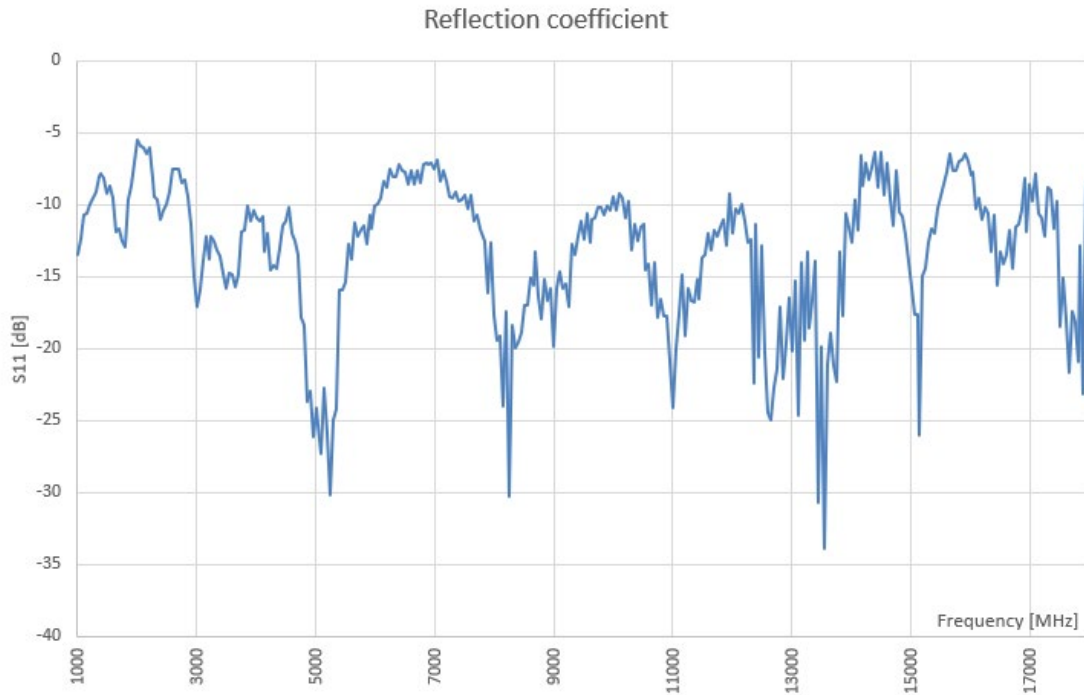


Figure 3: Reflection coefficient.



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Reference
105503-I10047-K352

Page
1 (8)

RISE
FoA

Calibration of EMCO 3115

Identification

Object	EMCO 3115 (Snr: 00143161)
Object state	Upon arrival the object had no specified visual damage.
Location	Borås, Sweden
Date	2021-09-25

Calibration procedure

The calibration was carried out in a fully anechoic chamber, using equipment with calibrations traceable to national standards. The calibration was carried out according to RISE-method 5594.

Results

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k . For scalar measurands, $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty has been determined in accordance with EA Publication EA-4/02. The long term stability of the calibrated object is not included in the reported expanded uncertainty of measurement.

Expanded uncertainty (Antenna Factor or Gain): ± 1.0 dB

RISE Research Institutes of Sweden AB

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Measurement conditionsFully anechoic chamber (Hertz)

Temperature 24 ± 1 °C
Relative humidity 32 % RH ± 10 %

Antenna factors and gain

The measured antenna factor / gain is provided in the tables and figures attached to this certificate. The reflection coefficient is provided as a courtesy. It should only be considered as a functionality check of the antenna and is not regarded as calibration data.

Type	Distance	Polarisation	Figure	Table
Antenna Gain (1 - 18 GHz)	3m	Vertical	1	1
Antenna Factor (1 - 18 GHz)	3m	Vertical	2	2
Reflection coefficient	-	-	3	-

Table 1: Antenna Gain.

F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]
1000	6.48	3500	10.64	6000	10.84	8500	11.38	11000	12.62
1050	7.04	3550	10.81	6050	10.83	8550	11.38	11050	12.68
1100	7.11	3600	10.77	6100	10.93	8600	11.57	11100	12.66
1150	7.14	3650	10.87	6150	10.77	8650	11.70	11150	12.77
1200	7.33	3700	10.82	6200	10.94	8700	11.67	11200	12.77
1250	7.14	3750	10.85	6250	10.89	8750	11.63	11250	12.89
1300	7.47	3800	10.87	6300	10.96	8800	11.49	11300	12.83
1350	7.74	3850	10.65	6350	11.10	8850	11.44	11350	12.83
1400	7.41	3900	10.71	6400	11.03	8900	11.43	11400	12.86
1450	8.09	3950	10.69	6450	11.10	8950	11.50	11450	12.82
1500	8.10	4000	10.59	6500	11.05	9000	11.59	11500	12.77
1550	8.37	4050	10.75	6550	10.74	9050	11.47	11550	12.68
1600	8.94	4100	10.72	6600	10.98	9100	11.53	11600	12.61
1650	8.88	4150	10.60	6650	10.97	9150	11.64	11650	12.60
1700	9.19	4200	10.68	6700	10.86	9200	11.77	11700	12.60
1750	9.10	4250	10.72	6750	10.75	9250	11.97	11750	12.74
1800	9.27	4300	10.98	6800	10.44	9300	11.90	11800	12.81
1850	9.48	4350	11.24	6850	10.59	9350	11.78	11850	12.91
1900	9.04	4400	11.33	6900	10.66	9400	11.76	11900	12.93
1950	8.80	4450	11.29	6950	10.64	9450	11.66	11950	13.00
2000	8.16	4500	11.33	7000	10.73	9500	11.60	12000	13.14
2050	7.47	4550	11.41	7050	10.56	9550	11.79	12050	13.19
2100	8.22	4600	11.47	7100	10.61	9600	11.88	12100	13.29
2150	8.35	4650	11.49	7150	10.60	9650	11.90	12150	13.23
2200	8.97	4700	11.50	7200	10.40	9700	11.91	12200	13.21
2250	9.71	4750	11.54	7250	10.53	9750	11.93	12250	13.22
2300	10.09	4800	11.41	7300	10.42	9800	12.08	12300	13.19
2350	10.23	4850	11.39	7350	10.38	9850	12.01	12350	13.33
2400	10.38	4900	11.39	7400	10.34	9900	12.00	12400	13.13
2450	10.32	4950	11.44	7450	10.41	9950	11.99	12450	13.20
2500	10.59	5000	11.35	7500	10.50	10000	11.87	12500	13.02
2550	10.31	5050	11.29	7550	10.64	10050	12.14	12550	13.08
2600	10.34	5100	11.39	7600	10.48	10100	12.03	12600	13.00
2650	9.82	5150	11.44	7650	10.57	10150	12.15	12650	12.90
2700	9.77	5200	11.80	7700	10.53	10200	12.22	12700	12.85
2750	10.05	5250	11.83	7750	10.77	10250	12.00	12750	12.71
2800	10.15	5300	12.03	7800	11.01	10300	12.19	12800	12.67
2850	10.23	5350	11.81	7850	11.12	10350	12.05	12850	12.59
2900	10.70	5400	11.79	7900	11.22	10400	12.09	12900	12.50
2950	10.74	5450	11.63	7950	11.35	10450	12.12	12950	12.43
3000	10.84	5500	11.20	8000	11.42	10500	12.04	13000	12.17
3050	10.63	5550	11.25	8050	11.67	10550	12.22	13050	12.13
3100	10.68	5600	11.23	8100	11.71	10600	12.20	13100	12.10
3150	10.72	5650	11.20	8150	11.87	10650	12.39	13150	12.11
3200	10.75	5700	11.50	8200	11.88	10700	12.42	13200	12.11
3250	10.80	5750	11.29	8250	11.72	10750	12.35	13250	12.04
3300	10.94	5800	11.45	8300	11.52	10800	12.41	13300	12.02
3350	10.49	5850	11.26	8350	11.40	10850	12.26	13350	12.00
3400	10.54	5900	11.10	8400	11.29	10900	12.43	13400	11.90
3450	10.29	5950	10.94	8450	11.30	10950	12.61	13450	12.02

F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]	F [MHz]	G [dBi]
13500	11.93	16000	15.10						
13550	11.89	16050	15.15						
13600	11.87	16100	15.05						
13650	11.76	16150	15.03						
13700	11.80	16200	14.92						
13750	11.75	16250	14.84						
13800	11.64	16300	14.78						
13850	11.60	16350	14.60						
13900	11.47	16400	14.61						
13950	11.48	16450	14.56						
14000	11.58	16500	14.57						
14050	11.65	16550	14.52						
14100	11.68	16600	14.44						
14150	11.77	16650	14.43						
14200	11.77	16700	14.33						
14250	11.97	16750	14.38						
14300	11.96	16800	14.37						
14350	12.05	16850	14.35						
14400	11.99	16900	14.32						
14450	11.98	16950	14.15						
14500	12.11	17000	14.11						
14550	12.27	17050	13.95						
14600	12.58	17100	13.95						
14650	12.71	17150	13.85						
14700	12.91	17200	13.66						
14750	13.10	17250	13.56						
14800	13.27	17300	13.48						
14850	13.43	17350	13.36						
14900	13.57	17400	13.38						
14950	13.63	17450	13.31						
15000	13.75	17500	13.44						
15050	13.89	17550	13.42						
15100	13.98	17600	13.53						
15150	14.13	17650	13.61						
15200	14.22	17700	13.60						
15250	14.33	17750	13.74						
15300	14.50	17800	13.69						
15350	14.62	17850	13.66						
15400	14.73	17900	13.61						
15450	14.89	17950	13.53						
15500	14.86	18000	13.47						
15550	15.01								
15600	14.97								
15650	15.00								
15700	15.13								
15750	15.02								
15800	15.16								
15850	15.03								
15900	15.18								
15950	15.13								

Table 2: Antenna Factor

F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]
1000	23.73	3500	30.46	6000	34.93	8500	37.42	11000	38.42
1050	23.60	3550	30.41	6050	35.02	8550	37.47	11050	38.40
1100	23.93	3600	30.57	6100	34.99	8600	37.33	11100	38.46
1150	24.29	3650	30.59	6150	35.22	8650	37.25	11150	38.39
1200	24.46	3700	30.75	6200	35.12	8700	37.33	11200	38.42
1250	25.01	3750	30.84	6250	35.24	8750	37.42	11250	38.34
1300	25.02	3800	30.93	6300	35.24	8800	37.61	11300	38.44
1350	25.08	3850	31.27	6350	35.16	8850	37.71	11350	38.48
1400	25.72	3900	31.32	6400	35.30	8900	37.76	11400	38.48
1450	25.35	3950	31.45	6450	35.31	8950	37.75	11450	38.57
1500	25.64	4000	31.66	6500	35.42	9000	37.70	11500	38.66
1550	25.64	4050	31.61	6550	35.79	9050	37.88	11550	38.78
1600	25.35	4100	31.74	6600	35.62	9100	37.86	11600	38.89
1650	25.68	4150	31.97	6650	35.70	9150	37.80	11650	38.94
1700	25.63	4200	32.00	6700	35.87	9200	37.71	11700	38.97
1750	25.97	4250	32.06	6750	36.04	9250	37.56	11750	38.87
1800	26.04	4300	31.90	6800	36.42	9300	37.68	11800	38.84
1850	26.07	4350	31.74	6850	36.34	9350	37.85	11850	38.77
1900	26.75	4400	31.75	6900	36.33	9400	37.91	11900	38.79
1950	27.21	4450	31.89	6950	36.41	9450	38.06	11950	38.76
2000	28.07	4500	31.94	7000	36.38	9500	38.16	12000	38.66
2050	28.98	4550	31.96	7050	36.61	9550	38.02	12050	38.64
2100	28.43	4600	31.99	7100	36.62	9600	37.98	12100	38.58
2150	28.51	4650	32.07	7150	36.70	9650	38.00	12150	38.67
2200	28.09	4700	32.15	7200	36.96	9700	38.04	12200	38.73
2250	27.55	4750	32.21	7250	36.89	9750	38.06	12250	38.75
2300	27.36	4800	32.43	7300	37.06	9800	37.96	12300	38.82
2350	27.40	4850	32.53	7350	37.16	9850	38.07	12350	38.71
2400	27.44	4900	32.62	7400	37.25	9900	38.12	12400	38.95
2450	27.67	4950	32.67	7450	37.24	9950	38.17	12450	38.91
2500	27.58	5000	32.83	7500	37.21	10000	38.34	12500	39.13
2550	28.03	5050	32.99	7550	37.13	10050	38.11	12550	39.10
2600	28.17	5100	32.97	7600	37.35	10100	38.26	12600	39.22
2650	28.85	5150	33.00	7650	37.31	10150	38.19	12650	39.35
2700	29.06	5200	32.73	7700	37.41	10200	38.16	12700	39.44
2750	28.95	5250	32.78	7750	37.22	10250	38.42	12750	39.61
2800	29.00	5300	32.67	7800	37.04	10300	38.27	12800	39.68
2850	29.08	5350	32.96	7850	36.99	10350	38.46	12850	39.80
2900	28.76	5400	33.07	7900	36.95	10400	38.46	12900	39.92
2950	28.86	5450	33.30	7950	36.87	10450	38.47	12950	40.03
3000	28.91	5500	33.82	8000	36.85	10500	38.59	13000	40.32
3050	29.27	5550	33.85	8050	36.66	10550	38.46	13050	40.39
3100	29.36	5600	33.95	8100	36.67	10600	38.52	13100	40.45
3150	29.46	5650	34.05	8150	36.56	10650	38.36	13150	40.48
3200	29.56	5700	33.83	8200	36.61	10700	38.38	13200	40.51
3250	29.65	5750	34.11	8250	36.82	10750	38.48	13250	40.61
3300	29.64	5800	34.03	8300	37.07	10800	38.47	13300	40.66
3350	30.22	5850	34.29	8350	37.24	10850	38.66	13350	40.72
3400	30.30	5900	34.53	8400	37.40	10900	38.53	13400	40.85
3450	30.68	5950	34.76	8450	37.44	10950	38.38	13450	40.77

F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]	F [MHz]	AF [dB/m]
13500	40.89	16000	39.19						
13550	40.96	16050	39.17						
13600	41.02	16100	39.30						
13650	41.15	16150	39.35						
13700	41.15	16200	39.48						
13750	41.23	16250	39.59						
13800	41.36	16300	39.67						
13850	41.44	16350	39.88						
13900	41.60	16400	39.90						
13950	41.62	16450	39.98						
14000	41.55	16500	39.99						
14050	41.51	16550	40.06						
14100	41.51	16600	40.18						
14150	41.45	16650	40.21						
14200	41.48	16700	40.33						
14250	41.32	16750	40.31						
14300	41.35	16800	40.34						
14350	41.30	16850	40.40						
14400	41.38	16900	40.45						
14450	41.43	16950	40.64						
14500	41.33	17000	40.71						
14550	41.20	17050	40.89						
14600	40.92	17100	40.92						
14650	40.81	17150	41.05						
14700	40.64	17200	41.26						
14750	40.48	17250	41.38						
14800	40.35	17300	41.49						
14850	40.21	17350	41.64						
14900	40.10	17400	41.64						
14950	40.07	17450	41.74						
15000	39.98	17500	41.63						
15050	39.87	17550	41.67						
15100	39.80	17600	41.59						
15150	39.69	17650	41.54						
15200	39.62	17700	41.57						
15250	39.54	17750	41.46						
15300	39.40	17800	41.52						
15350	39.31	17850	41.58						
15400	39.23	17900	41.65						
15450	39.10	17950	41.76						
15500	39.16	18000	41.85						
15550	39.03								
15600	39.11								
15650	39.10								
15700	39.00								
15750	39.14								
15800	39.02								
15850	39.18								
15900	39.05								
15950	39.14								

Figure 1: Antenna Gain.



Figure 2: Antenna Factor.

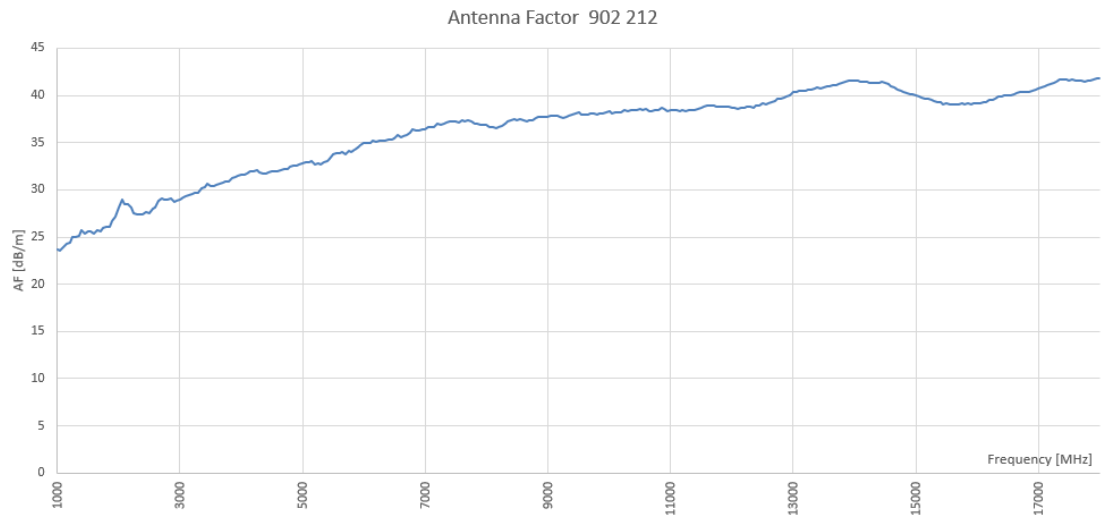


Figure 4: Reflection coefficient**RISE Research Institutes of Sweden AB
Electronics - EMC**

Performed by

Mats Cedheim

End of the calibration certificate.

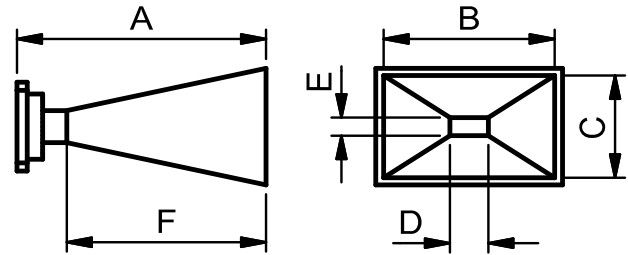


Standard Gain Horn

Model 20240-20

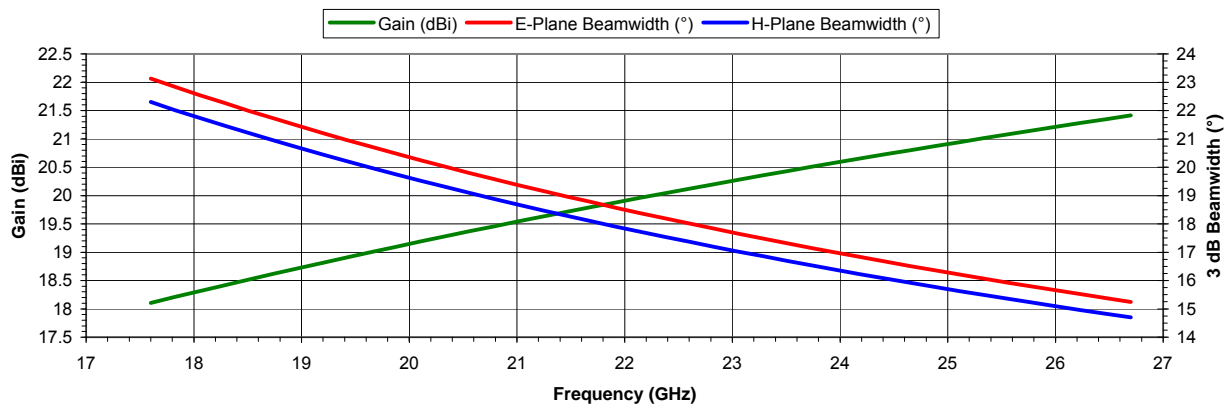
Waveguide Size: WG20 (WR42, R220)
 Nominal Gain: 20 dBi
 Operating Frequencies: 17.6 - 26.7 GHz

Overall Length (A): 120.3 mm (4.736 inch)
 Aperture Width (B): 52.00 mm (2.047 inch)
 Aperture Height (C): 37.40 mm (1.472 inch)
 Waveguide Width (D): 10.668 mm (0.420 inch)
 Waveguide Height (E): 4.318 mm (0.170 inch)
 Flare Length (F): 115.20 mm (4.535 inch)



Typical Performance Data

Frequency (GHz)	Gain (dBi)	Beamwidth		Frequency (GHz)	Gain (dBi)	Beamwidth		Frequency (GHz)	Gain (dBi)	Beamwidth	
		E-Plane	H-Plane			E-Plane	H-Plane			E-Plane	H-Plane
17.6	18.11	23.1°	22.3°	20.7	19.42	19.7°	19.0°	23.85	20.54	17.1°	16.5°
17.7	18.15	23.0°	22.2°	20.85	19.48	19.5°	18.8°	24	20.59	17.0°	16.4°
17.85	18.22	22.8°	22.0°	21	19.54	19.4°	18.7°	24.15	20.64	16.9°	16.3°
18	18.29	22.6°	21.8°	21.15	19.59	19.2°	18.6°	24.3	20.69	16.8°	16.2°
18.15	18.36	22.4°	21.6°	21.3	19.65	19.1°	18.4°	24.45	20.74	16.6°	16.1°
18.3	18.42	22.2°	21.4°	21.45	19.71	19.0°	18.3°	24.6	20.79	16.5°	16.0°
18.45	18.49	22.1°	21.3°	21.6	19.76	18.8°	18.2°	24.75	20.83	16.4°	15.9°
18.6	18.56	21.9°	21.1°	21.75	19.82	18.7°	18.0°	24.9	20.88	16.3°	15.8°
18.75	18.62	21.7°	20.9°	21.9	19.87	18.6°	17.9°	25.05	20.93	16.3°	15.7°
18.9	18.69	21.5°	20.8°	22.05	19.93	18.5°	17.8°	25.2	20.97	16.2°	15.6°
19.05	18.75	21.4°	20.6°	22.2	19.98	18.3°	17.7°	25.35	21.02	16.1°	15.5°
19.2	18.82	21.2°	20.4°	22.35	20.03	18.2°	17.6°	25.5	21.06	16.0°	15.4°
19.35	18.88	21.0°	20.3°	22.5	20.09	18.1°	17.4°	25.65	21.11	15.9°	15.3°
19.5	18.94	20.9°	20.1°	22.65	20.14	18.0°	17.3°	25.8	21.15	15.8°	15.2°
19.65	19.00	20.7°	20.0°	22.8	20.19	17.9°	17.2°	25.95	21.20	15.7°	15.1°
19.8	19.06	20.6°	19.8°	22.95	20.24	17.7°	17.1°	26.1	21.24	15.6°	15.0°
19.95	19.13	20.4°	19.7°	23.1	20.29	17.6°	17.0°	26.25	21.28	15.5°	15.0°
20.1	19.19	20.3°	19.5°	23.25	20.35	17.5°	16.9°	26.4	21.33	15.4°	14.9°
20.25	19.25	20.1°	19.4°	23.4	20.40	17.4°	16.8°	26.55	21.37	15.3°	14.8°
20.4	19.31	20.0°	19.2°	23.55	20.45	17.3°	16.7°	26.7	21.41	15.2°	14.7°
20.55	19.36	19.8°	19.1°	23.7	20.50	17.2°	16.6°				



Notes:

Gain calculations based on NRL Report 4433 - accuracy to approx ± 0.3dBi
 Half-power (3dB) beamwidth estimates calculated using $50.8 \lambda / C$ (E-Plane) and $68.1 \lambda / B$ (H-Plane). This is a 'large aperture' approximation that breaks down at gain values smaller than around 12 dBi. For 10dBi Standard Gain Horns, beamwidths are approximately 63° at the lowest frequency and 48° at the highest frequency.

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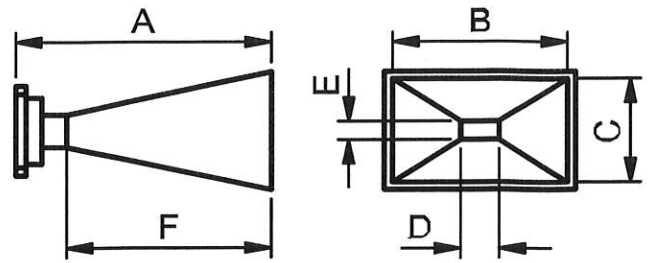
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STANDARD GAIN HORN

Model 22240-20

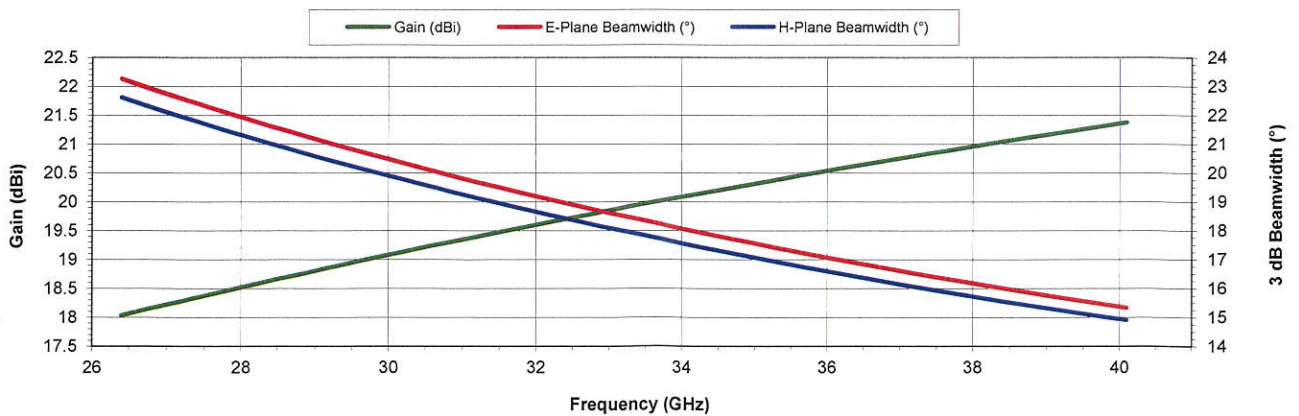
Waveguide Size: WG22 (WR28, R320)
 Nominal Gain: 20 dBi
 Operating Frequencies: 26.4 - 40.1 GHz

Overall Length (A): 86.0 mm (3.386 inch)
 Aperture Width (B): 34.20 mm (1.346 inch)
 Aperture Height (C): 24.80 mm (0.976 inch)
 Waveguide Width (D): 7.112 mm (0.280 inch)
 Waveguide Height (E): 3.556 mm (0.140 inch)
 Flare Length (F): 75.00 mm (2.953 inch)



Typical Performance Data

Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane	Beamwidth H-Plane	Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane	Beamwidth H-Plane	Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane	Beamwidth H-Plane
26.4	18.03	23.3°	22.6°	31.5	19.47	19.5°	18.9°	36.75	20.69	16.7°	16.2°
26.5	18.06	23.2°	22.5°	31.75	19.53	19.3°	18.8°	37	20.74	16.6°	16.1°
26.75	18.14	22.9°	22.3°	32	19.60	19.2°	18.6°	37.25	20.80	16.5°	16.0°
27	18.22	22.7°	22.1°	32.25	19.66	19.0°	18.5°	37.5	20.85	16.4°	15.9°
27.25	18.29	22.5°	21.9°	32.5	19.72	18.9°	18.4°	37.75	20.90	16.3°	15.8°
27.5	18.37	22.3°	21.7°	32.75	19.78	18.7°	18.2°	38	20.95	16.2°	15.7°
27.75	18.44	22.1°	21.5°	33	19.84	18.6°	18.1°	38.25	21.00	16.0°	15.6°
28	18.52	21.9°	21.3°	33.25	19.90	18.5°	17.9°	38.5	21.05	15.9°	15.5°
28.25	18.59	21.7°	21.1°	33.5	19.96	18.3°	17.8°	38.75	21.10	15.8°	15.4°
28.5	18.66	21.5°	20.9°	33.75	20.02	18.2°	17.7°	39	21.15	15.7°	15.3°
28.75	18.73	21.4°	20.8°	34	20.08	18.1°	17.6°	39.25	21.20	15.6°	15.2°
29	18.80	21.2°	20.6°	34.25	20.14	17.9°	17.4°	39.5	21.25	15.5°	15.1°
29.25	18.87	21.0°	20.4°	34.5	20.19	17.8°	17.3°	39.75	21.30	15.4°	15.0°
29.5	18.94	20.8°	20.2°	34.75	20.25	17.7°	17.2°	40	21.34	15.3°	14.9°
29.75	19.01	20.6°	20.1°	35	20.31	17.5°	17.1°	40.1	21.36	15.3°	14.9°
30	19.08	20.5°	19.9°	35.25	20.36	17.4°	16.9°				
30.25	19.14	20.3°	19.7°	35.5	20.42	17.3°	16.8°				
30.5	19.21	20.1°	19.6°	35.75	20.48	17.2°	16.7°				
30.75	19.28	20.0°	19.4°	36	20.53	17.1°	16.6°				
31	19.34	19.8°	19.3°	36.25	20.58	16.9°	16.5°				
31.25	19.41	19.6°	19.1°	36.5	20.64	16.8°	16.3°				



Notes:

Gain calculations based on NRL Report 4433 - accuracy to approx ± 0.3dBi. Antenna Gain is only valid within the 'far-field' of the antenna. For more details, please see Ch 16, 'Antenna Theory, Analysis & Design' Balanis, Wiley or Ch 18 'Antenna', Kraus, McGraw-Hill. Half-power (3dB) beamwidth estimates calculated using $50.8 \lambda / C$ (E-Plane) and $68.1 \lambda / B$ (H-Plane). This is a 'large aperture' approximation that breaks down at gain values smaller than around 12 dBi. For 10dBi Standard Gain Horns, beamwidths are approximately 63° at the lowest frequency and 48° at the highest frequency.



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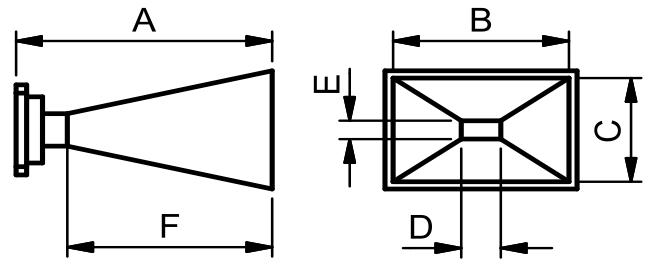


STANDARD GAIN HORN

Model 24240-20

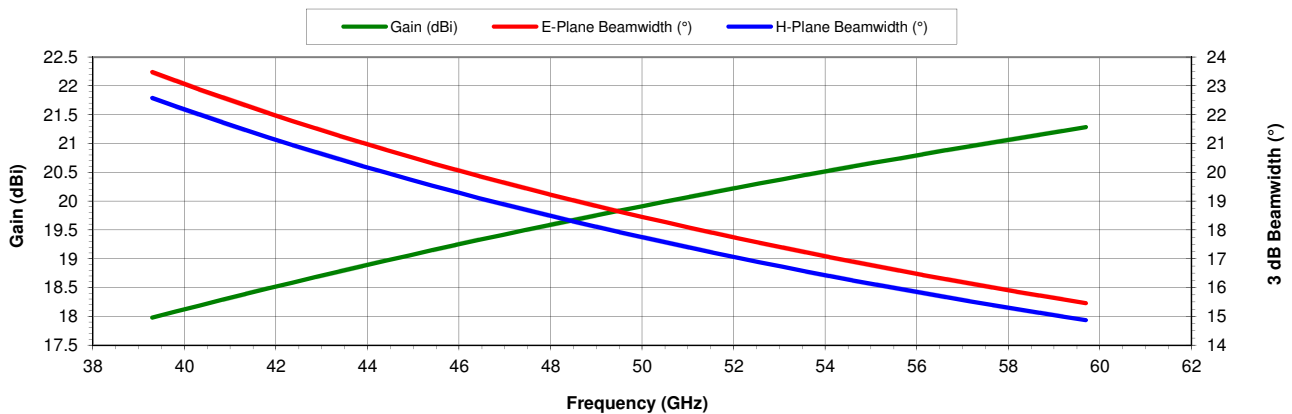
Waveguide Size: WG24 (WR19, R500)
 Nominal Gain: 20 dBi
 Operating Frequencies: 39.3 - 59.7 GHz

Overall Length (A): 54.4 mm (2.142 inch)
 Aperture Width (B): 23.00 mm (0.906 inch)
 Aperture Height (C): 16.50 mm (0.650 inch)
 Waveguide Width (D): 4.775 mm (0.188 inch)
 Waveguide Height (E): 2.388 mm (0.094 inch)
 Flare Length (F): 48.00 mm (1.890 inch)



Typical Performance Data

Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane (°)	Beamwidth H-Plane (°)	Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane (°)	Beamwidth H-Plane (°)	Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane (°)	Beamwidth H-Plane (°)
39.3	17.98	23.5°	22.6°	47.6	19.52	19.4°	18.6°	56	20.79	16.5°	15.8°
39.6	18.04	23.3°	22.4°	48	19.59	19.2°	18.5°	56.4	20.85	16.4°	15.7°
40	18.12	23.1°	22.2°	48.4	19.66	19.1°	18.3°	56.8	20.90	16.2°	15.6°
40.4	18.20	22.8°	22.0°	48.8	19.72	18.9°	18.2°	57.2	20.96	16.1°	15.5°
40.8	18.28	22.6°	21.7°	49.2	19.79	18.8°	18.0°	57.6	21.01	16.0°	15.4°
41.2	18.36	22.4°	21.5°	49.6	19.85	18.6°	17.9°	58	21.06	15.9°	15.3°
41.6	18.44	22.2°	21.3°	50	19.91	18.5°	17.7°	58.4	21.12	15.8°	15.2°
42	18.52	22.0°	21.1°	50.4	19.98	18.3°	17.6°	58.8	21.17	15.7°	15.1°
42.4	18.59	21.8°	20.9°	50.8	20.04	18.2°	17.5°	59.2	21.22	15.6°	15.0°
42.8	18.67	21.6°	20.7°	51.2	20.10	18.0°	17.3°	59.6	21.27	15.5°	14.9°
43.2	18.75	21.4°	20.5°	51.6	20.16	17.9°	17.2°	59.7	21.28	15.5°	14.9°
43.6	18.82	21.2°	20.4°	52	20.22	17.7°	17.1°				
44	18.89	21.0°	20.2°	52.4	20.28	17.6°	16.9°				
44.4	18.97	20.8°	20.0°	52.8	20.34	17.5°	16.8°				
44.8	19.04	20.6°	19.8°	53.2	20.40	17.3°	16.7°				
45.2	19.11	20.4°	19.6°	53.6	20.46	17.2°	16.6°				
45.6	19.18	20.2°	19.5°	54	20.51	17.1°	16.4°				
46	19.25	20.1°	19.3°	54.4	20.57	17.0°	16.3°				
46.4	19.32	19.9°	19.1°	54.8	20.63	16.8°	16.2°				
46.8	19.39	19.7°	19.0°	55.2	20.68	16.7°	16.1°				
47.2	19.46	19.5°	18.8°	55.6	20.74	16.6°	16.0°				



Notes:

Gain calculations based on NRL Report 4433 - accuracy to approx ± 0.3 dBi. Antenna Gain is only valid within the 'far-field' of the antenna. For more details, please see Ch 16, 'Antenna Theory, Analysis & Design' Balanis, Wiley or Ch 18 'Antenna', Kraus, McGraw-Hill.

Half-power (3dB) beamwidth estimates calculated using $50.8 \lambda / C$ (E-Plane) and $68.1 \lambda / B$ (H-Plane). This is a 'large aperture' approximation that breaks down at gain values smaller than around 12 dBi. For 10dBi Standard Gain Horns, beamwidths are approximately 63° at the lowest frequency and 48° at the highest frequency.



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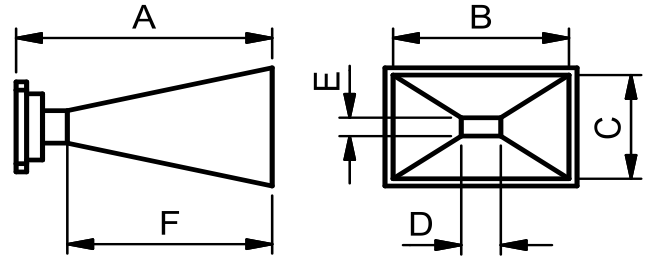


STANDARD GAIN HORN

Model 26240-20

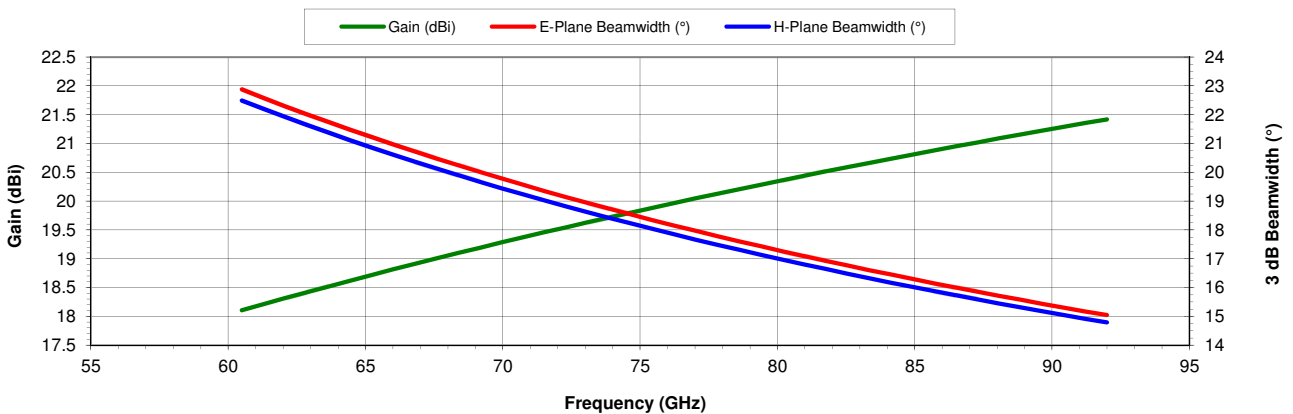
Waveguide Size: WG26 (WR12, R740)
 Nominal Gain: 20 dBi
 Operating Frequencies: 60.5 - 92 GHz

Overall Length (A): 38.4 mm (1.512 inch)
 Aperture Width (B): 15.00 mm (0.591 inch)
 Aperture Height (C): 11.00 mm (0.433 inch)
 Waveguide Width (D): 3.099 mm (0.122 inch)
 Waveguide Height (E): 1.549 mm (0.061 inch)
 Flare Length (F): 32.00 mm (1.260 inch)



Typical Performance Data

Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane (°)	Beamwidth H-Plane (°)	Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane (°)	Beamwidth H-Plane (°)	Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane (°)	Beamwidth H-Plane (°)
60.5	18.11	22.9°	22.5°	71	19.40	19.5°	19.2°	81.5	20.49	17.0°	16.7°
61	18.17	22.7°	22.3°	71.5	19.46	19.4°	19.0°	82	20.54	16.9°	16.6°
61.5	18.24	22.5°	22.1°	72	19.51	19.2°	18.9°	82.5	20.59	16.8°	16.5°
62	18.31	22.3°	21.9°	72.5	19.57	19.1°	18.8°	83	20.63	16.7°	16.4°
62.5	18.37	22.1°	21.8°	73	19.62	19.0°	18.6°	83.5	20.68	16.6°	16.3°
63	18.44	22.0°	21.6°	73.5	19.68	18.8°	18.5°	84	20.72	16.5°	16.2°
63.5	18.50	21.8°	21.4°	74	19.73	18.7°	18.4°	84.5	20.77	16.4°	16.1°
64	18.57	21.6°	21.3°	74.5	19.79	18.6°	18.3°	85	20.82	16.3°	16.0°
64.5	18.63	21.5°	21.1°	75	19.84	18.5°	18.1°	85.5	20.86	16.2°	15.9°
65	18.69	21.3°	20.9°	75.5	19.89	18.3°	18.0°	86	20.91	16.1°	15.8°
65.5	18.75	21.1°	20.8°	76	19.94	18.2°	17.9°	86.5	20.95	16.0°	15.7°
66	18.81	21.0°	20.6°	76.5	19.99	18.1°	17.8°	87	20.99	15.9°	15.6°
66.5	18.88	20.8°	20.5°	77	20.05	18.0°	17.7°	87.5	21.04	15.8°	15.5°
67	18.94	20.7°	20.3°	77.5	20.10	17.9°	17.6°	88	21.08	15.7°	15.5°
67.5	19.00	20.5°	20.2°	78	20.15	17.7°	17.4°	88.5	21.13	15.6°	15.4°
68	19.06	20.4°	20.0°	78.5	20.20	17.6°	17.3°	89	21.17	15.6°	15.3°
68.5	19.11	20.2°	19.9°	79	20.25	17.5°	17.2°	89.5	21.21	15.5°	15.2°
69	19.17	20.1°	19.7°	79.5	20.30	17.4°	17.1°	90	21.25	15.4°	15.1°
69.5	19.23	19.9°	19.6°	80	20.35	17.3°	17.0°	90.5	21.30	15.3°	15.0°
70	19.29	19.8°	19.4°	80.5	20.39	17.2°	16.9°	91	21.34	15.2°	15.0°
70.5	19.35	19.6°	19.3°	81	20.44	17.1°	16.8°	91.5	21.38	15.1°	14.9°



Notes:

Gain calculations based on NRL Report 4433 - accuracy to approx ± 0.3 dBi. Antenna Gain is only valid within the 'far-field' of the antenna. For more details, please see Ch 16, 'Antenna Theory, Analysis & Design' Balanis, Wiley or Ch 18 'Antenna', Kraus, McGraw-Hill.

Half-power (3dB) beamwidth estimates calculated using $50.8 \lambda / C$ (E-Plane) and $68.1 \lambda / B$ (H-Plane). This is a 'large aperture' approximation that breaks down at gain values smaller than around 12 dBi. For 10dBi Standard Gain Horns, beamwidths are approximately 63° at the lowest frequency and 48° at the highest frequency.



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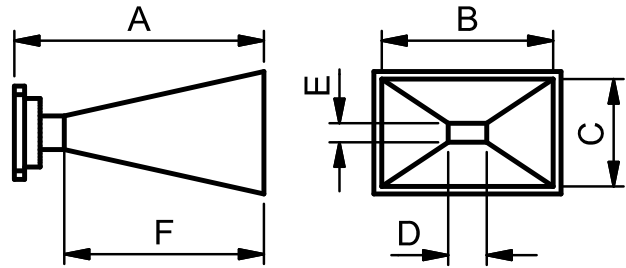


Standard Gain Horn

Model 27240-20

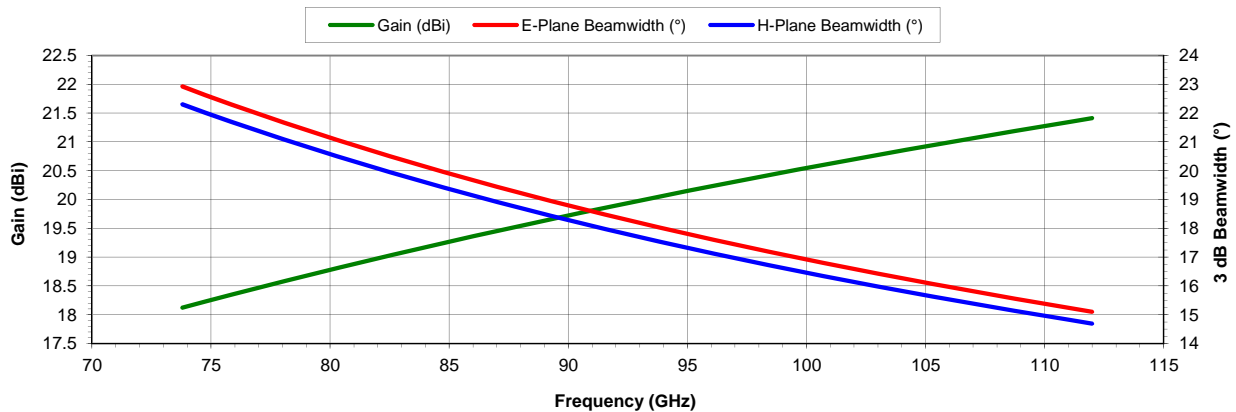
Waveguide Size: WG27 (WR10, R900)
 Nominal Gain: 20 dBi
 Operating Frequencies: 73.8 - 112 GHz

Overall Length (A): 32.5 mm (1.280 inch)
 Aperture Width (B): 12.40 mm (0.488 inch)
 Aperture Height (C): 9.00 mm (0.354 inch)
 Waveguide Width (D): 2.540 mm (0.100 inch)
 Waveguide Height (E): 1.270 mm (0.050 inch)
 Flare Length (F): 26.00 mm (1.024 inch)



Typical Performance Data

Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane	Beamwidth H-Plane	Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane	Beamwidth H-Plane	Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane	Beamwidth H-Plane
73.8	18.12	22.9°	22.3°	89.25	19.66	19.0°	18.4°	105	20.92	16.1°	15.7°
74.25	18.17	22.8°	22.2°	90	19.72	18.8°	18.3°	105.75	20.98	16.0°	15.6°
75	18.26	22.6°	21.9°	90.75	19.79	18.6°	18.1°	106.5	21.03	15.9°	15.5°
75.75	18.34	22.3°	21.7°	91.5	19.85	18.5°	18.0°	107.25	21.08	15.8°	15.3°
76.5	18.42	22.1°	21.5°	92.25	19.92	18.3°	17.8°	108	21.14	15.7°	15.2°
77.25	18.50	21.9°	21.3°	93	19.98	18.2°	17.7°	108.75	21.19	15.6°	15.1°
78	18.57	21.7°	21.1°	93.75	20.04	18.0°	17.6°	109.5	21.24	15.4°	15.0°
78.75	18.65	21.5°	20.9°	94.5	20.11	17.9°	17.4°	110.25	21.29	15.3°	14.9°
79.5	18.73	21.3°	20.7°	95.25	20.17	17.8°	17.3°	111	21.34	15.2°	14.8°
80.25	18.80	21.1°	20.5°	96	20.23	17.6°	17.1°	111.75	21.39	15.1°	14.7°
81	18.88	20.9°	20.3°	96.75	20.29	17.5°	17.0°	112	21.41	15.1°	14.7°
81.75	18.95	20.7°	20.1°	97.5	20.35	17.3°	16.9°				
82.5	19.03	20.5°	20.0°	98.25	20.41	17.2°	16.8°				
83.25	19.10	20.3°	19.8°	99	20.47	17.1°	16.6°				
84	19.17	20.1°	19.6°	99.75	20.53	17.0°	16.5°				
84.75	19.24	20.0°	19.4°	100.5	20.58	16.8°	16.4°				
85.5	19.31	19.8°	19.3°	101.25	20.64	16.7°	16.3°				
86.25	19.38	19.6°	19.1°	102	20.70	16.6°	16.1°				
87	19.45	19.4°	18.9°	102.75	20.76	16.5°	16.0°				
87.75	19.52	19.3°	18.8°	103.5	20.81	16.3°	15.9°				
88.5	19.59	19.1°	18.6°	104.25	20.87	16.2°	15.8°				



Notes:

Gain calculations based on NRL Report 4433 - accuracy to approx ± 0.3dBi
 Half-power (3dB) beamwidth estimates calculated using $50.8 \lambda / C$ (E-Plane) and $68.1 \lambda / B$ (H-Plane). This is a 'large aperture' approximation that breaks down at gain values smaller than around 12 dBi. For 10dBi Standard Gain Horns, beamwidths are approximately 63° at the lowest frequency and 48° at the highest frequency.



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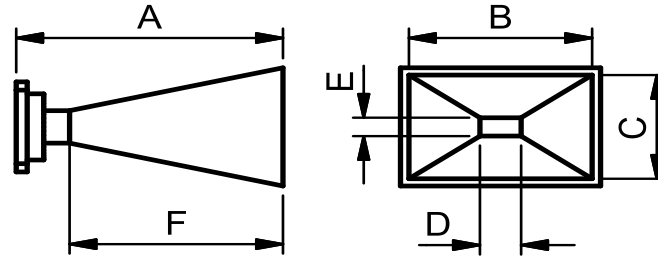


STANDARD GAIN HORN

Model 29240-20

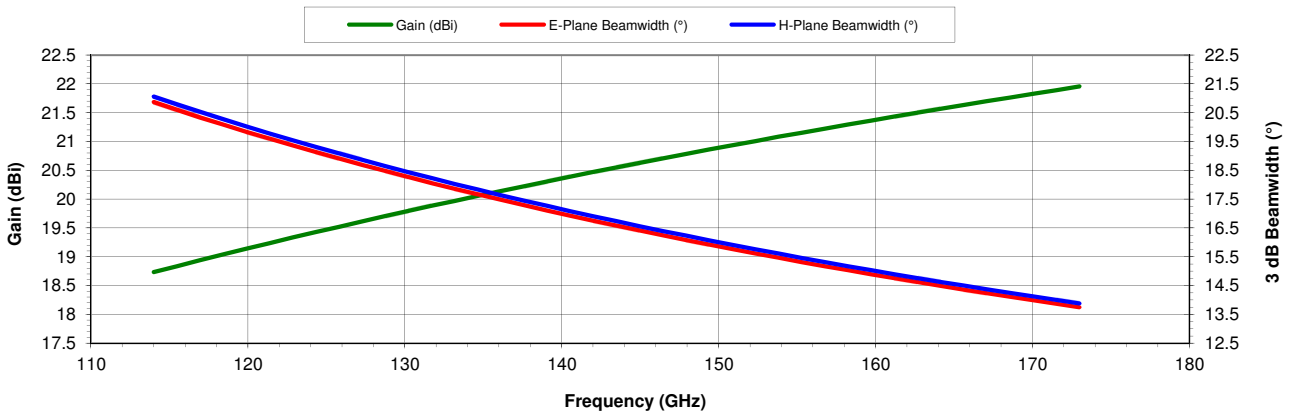
Waveguide Size: WG29 (WR6, R1400)
 Nominal Gain: 20 dBi
 Operating Frequencies: 114 - 173 GHz

Overall Length (A): 24.4 mm (0.961 inch)
 Aperture Width (B): 8.50 mm (0.335 inch)
 Aperture Height (C): 6.40 mm (0.252 inch)
 Waveguide Width (D): 1.651 mm (0.065 inch)
 Waveguide Height (E): 0.826 mm (0.033 inch)
 Flare Length (F): 18.00 mm (0.709 inch)



Typical Performance Data

Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane	Beamwidth H-Plane	Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane	Beamwidth H-Plane	Frequency (GHz)	Gain (dBi)	Beamwidth E-Plane	Beamwidth H-Plane
114	18.73	20.9°	21.1°	135	20.08	17.6°	17.8°	156	21.19	15.2°	15.4°
115	18.80	20.7°	20.9°	136	20.13	17.5°	17.7°	157	21.24	15.2°	15.3°
116	18.87	20.5°	20.7°	137	20.19	17.4°	17.5°	158	21.28	15.1°	15.2°
117	18.94	20.3°	20.5°	138	20.25	17.2°	17.4°	159	21.33	15.0°	15.1°
118	19.01	20.2°	20.3°	139	20.30	17.1°	17.3°	160	21.38	14.9°	15.0°
119	19.08	20.0°	20.2°	140	20.36	17.0°	17.2°	161	21.42	14.8°	14.9°
120	19.14	19.8°	20.0°	141	20.42	16.9°	17.0°	162	21.47	14.7°	14.8°
121	19.21	19.7°	19.8°	142	20.47	16.8°	16.9°	163	21.52	14.6°	14.7°
122	19.28	19.5°	19.7°	143	20.52	16.6°	16.8°	164	21.56	14.5°	14.6°
123	19.34	19.3°	19.5°	144	20.58	16.5°	16.7°	165	21.61	14.4°	14.6°
124	19.41	19.2°	19.4°	145	20.63	16.4°	16.6°	166	21.65	14.3°	14.5°
125	19.47	19.0°	19.2°	146	20.68	16.3°	16.4°	167	21.70	14.2°	14.4°
126	19.53	18.9°	19.1°	147	20.74	16.2°	16.3°	168	21.74	14.2°	14.3°
127	19.60	18.7°	18.9°	148	20.79	16.1°	16.2°	169	21.78	14.1°	14.2°
128	19.66	18.6°	18.8°	149	20.84	16.0°	16.1°	170	21.83	14.0°	14.1°
129	19.72	18.4°	18.6°	150	20.89	15.9°	16.0°	171	21.87	13.9°	14.0°
130	19.78	18.3°	18.5°	151	20.94	15.8°	15.9°	172	21.91	13.8°	14.0°
131	19.84	18.2°	18.3°	152	20.99	15.7°	15.8°	173	21.95	13.8°	13.9°
132	19.90	18.0°	18.2°	153	21.04	15.5°	15.7°				
133	19.96	17.9°	18.1°	154	21.09	15.4°	15.6°				
134	20.02	17.8°	17.9°	155	21.14	15.3°	15.5°				



Notes:

Gain calculations based on NRL Report 4433 - accuracy to approx ± 0.3 dBi. Antenna Gain is only valid within the 'far-field' of the antenna. For more details, please see Ch 16, 'Antenna Theory, Analysis & Design' Balanis, Wiley or Ch 18 'Antenna', Kraus, McGraw-Hill.

Half-power (3dB) beamwidth estimates calculated using $50.8 \lambda / C$ (E-Plane) and $68.1 \lambda / B$ (H-Plane). This is a 'large aperture' approximation that breaks down at gain values smaller than around 12 dBi. For 10dBi Standard Gain Horns, beamwidths are approximately 63° at the lowest frequency and 48° at the highest frequency.



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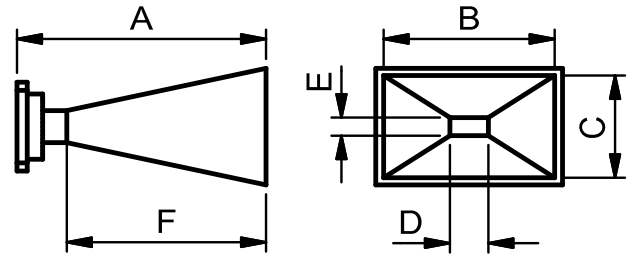


Standard Gain Horn

Model 30240-20

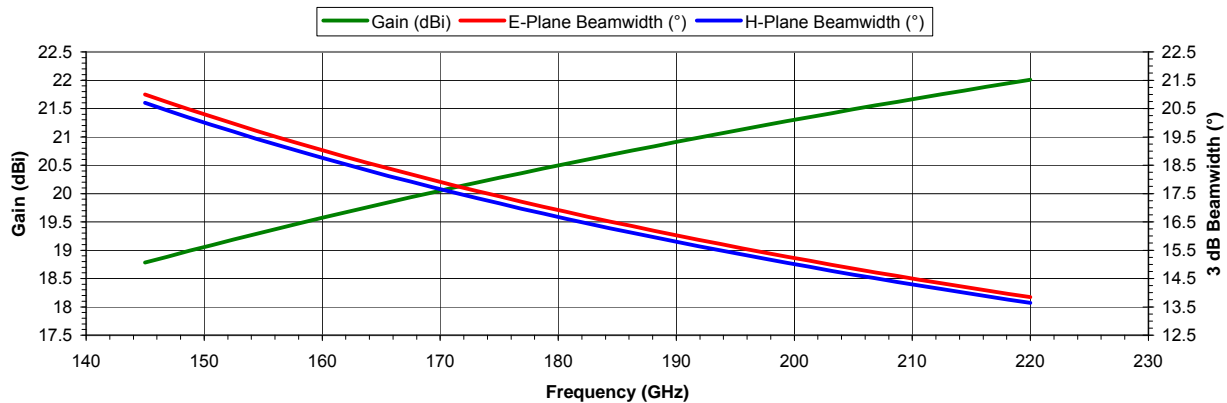
Waveguide Size: WG30 (WR5, R1800)
 Nominal Gain: 20 dBi
 Operating Frequencies: 145 - 220 GHz

Overall Length (A): 17.5 mm (0.689 inch)
 Aperture Width (B): 6.80 mm (0.268 inch)
 Aperture Height (C): 5.00 mm (0.197 inch)
 Waveguide Width (D): 1.295 mm (0.051 inch)
 Waveguide Height (E): 0.648 mm (0.026 inch)
 Flare Length (F): 14.50 mm (0.571 inch)



Typical Performance Data

Frequency (GHz)	Gain (dBi)	Beamwidth		Frequency (GHz)	Gain (dBi)	Beamwidth		Frequency (GHz)	Gain (dBi)	Beamwidth	
		E-Plane	H-Plane			E-Plane	H-Plane			E-Plane	H-Plane
145	18.78	21.0°	20.7°	175.5	20.30	17.3°	17.1°	207	21.56	14.7°	14.5°
145.5	18.81	20.9°	20.6°	177	20.37	17.2°	17.0°	208.5	21.61	14.6°	14.4°
147	18.89	20.7°	20.4°	178.5	20.43	17.1°	16.8°	210	21.67	14.5°	14.3°
148.5	18.98	20.5°	20.2°	180	20.50	16.9°	16.7°	211.5	21.72	14.4°	14.2°
150	19.06	20.3°	20.0°	181.5	20.56	16.8°	16.5°	213	21.77	14.3°	14.1°
151.5	19.14	20.1°	19.8°	183	20.62	16.6°	16.4°	214.5	21.82	14.2°	14.0°
153	19.21	19.9°	19.6°	184.5	20.69	16.5°	16.3°	216	21.87	14.1°	13.9°
154.5	19.29	19.7°	19.4°	186	20.75	16.4°	16.1°	217.5	21.92	14.0°	13.8°
156	19.37	19.5°	19.2°	187.5	20.81	16.2°	16.0°	219	21.97	13.9°	13.7°
157.5	19.45	19.3°	19.1°	189	20.87	16.1°	15.9°	220	22.01	13.8°	13.6°
159	19.52	19.2°	18.9°	190.5	20.93	16.0°	15.8°				
160.5	19.60	19.0°	18.7°	192	20.99	15.9°	15.6°				
162	19.67	18.8°	18.5°	193.5	21.05	15.7°	15.5°				
163.5	19.74	18.6°	18.4°	195	21.11	15.6°	15.4°				
165	19.82	18.5°	18.2°	196.5	21.17	15.5°	15.3°				
166.5	19.89	18.3°	18.0°	198	21.23	15.4°	15.2°				
168	19.96	18.1°	17.9°	199.5	21.28	15.3°	15.0°				
169.5	20.03	18.0°	17.7°	201	21.34	15.1°	14.9°				
171	20.10	17.8°	17.6°	202.5	21.39	15.0°	14.8°				
172.5	20.16	17.7°	17.4°	204	21.45	14.9°	14.7°				
174	20.23	17.5°	17.2°	205.5	21.50	14.8°	14.6°				



Notes:

Gain calculations based on NRL Report 4433 - accuracy to approx ± 0.3 dBi
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