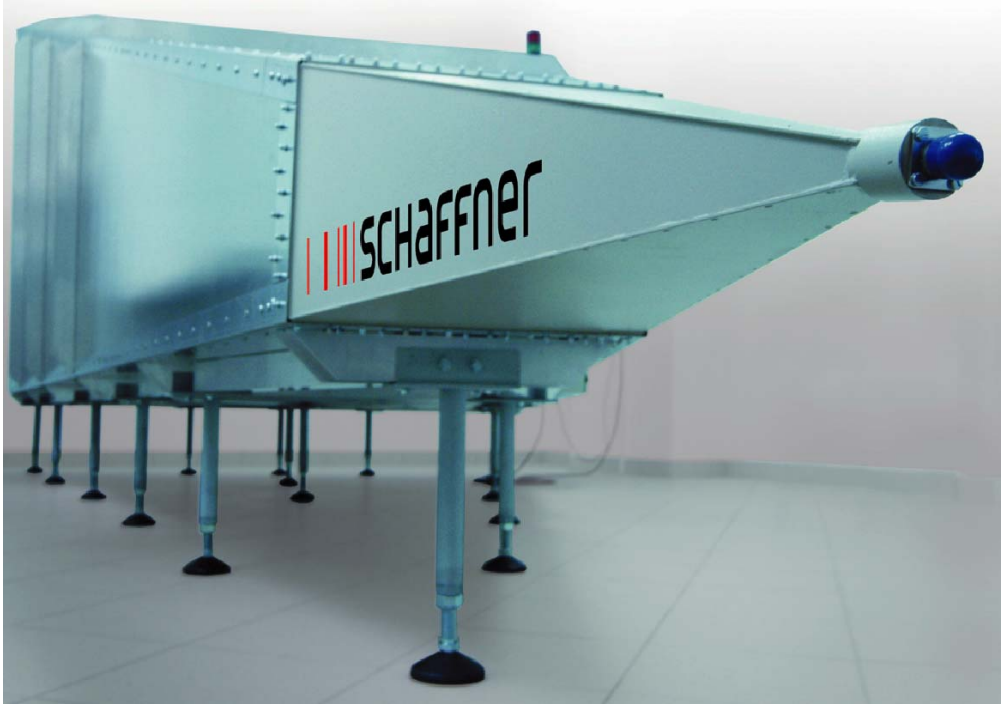
GTEM cells

Application note:

Alternative emission measurements on automotive components below 30 MHz in a GTEM cell



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Contents

1 General

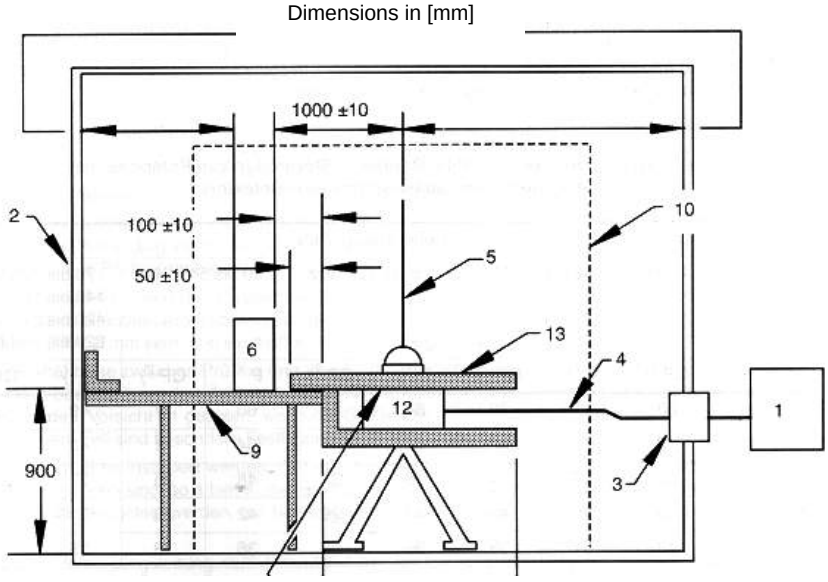
- measurement of the electric field strength below 30 MHz
- applications: automotive components, airborne equipment and military
- standards: - CISPR 25
  - RTCA DO 160C/D/E
  - MIL 461/462

1.1 Measurement set-up in general

- measuring device: rod antenna
- rod antenna in 1 m distance to the device under test (DUT)
- metal table: width of screened room, depth min. 1m
- all 3 edges of the table carefully connected to the walls of the screened room
- test cable 1.5 m long, 10 cm distance from front edge of the table
- one side of the cable: DUT
- other side of the cable: LISN

1.2 Measurement set-up (from CISPR 25)

Dimensions in [mm]



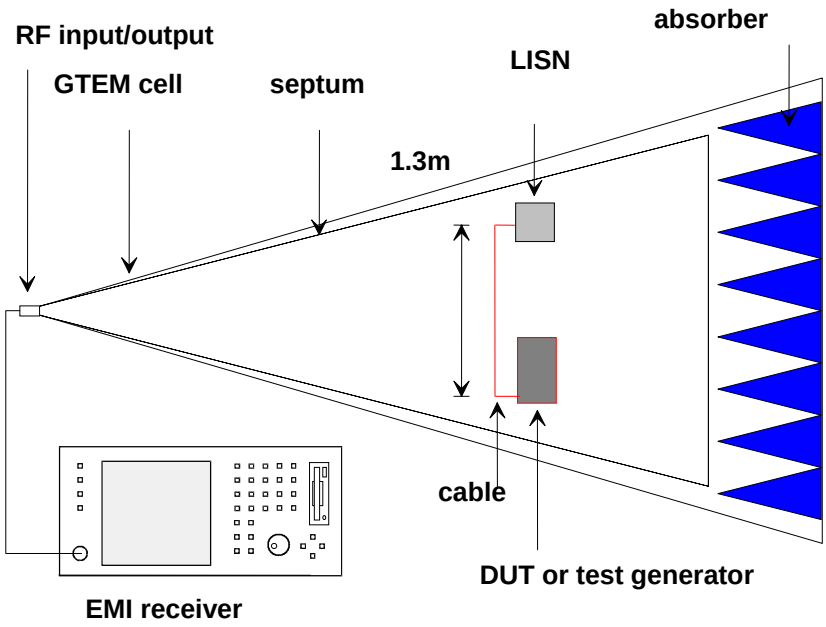
1.3 Problems with standard procedure

- proper grounding required, difficult in OATS and FAR
- hence, size of ground plane has influence
- resonant set-up with DUT possible
- standard requires only minimum size
- ideal: infinite large ground plane

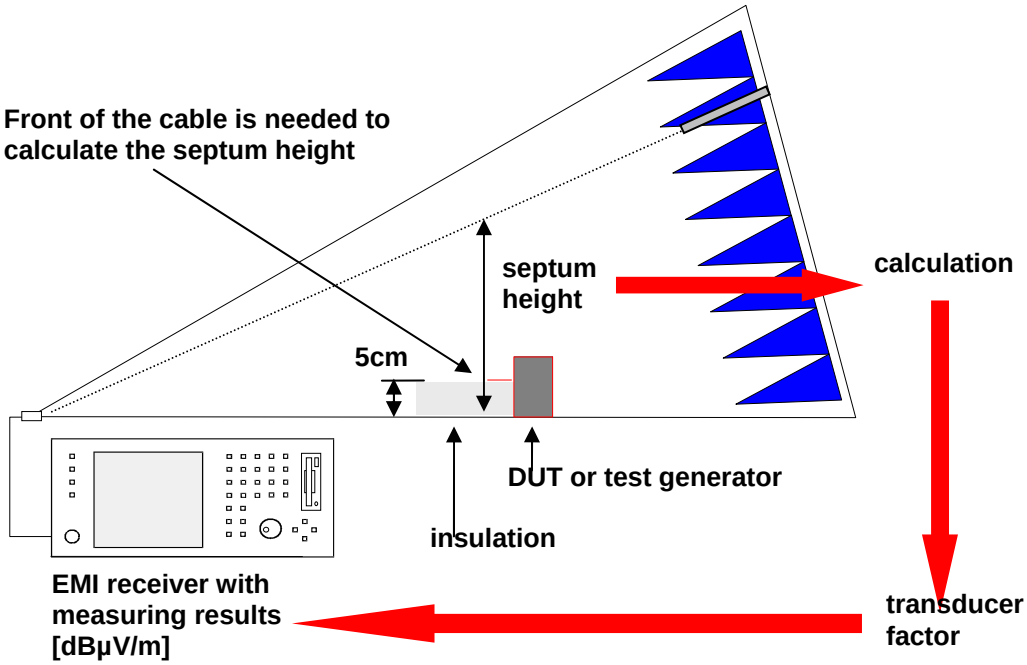
2 Alternative procedure – GTEM cell

- GTEM cell suitable for measurement of vertical E-fields (similar to rod antenna)
- set-up in GTEM cell similar to standard
- DUT on the floor of GTEM-cell
- test cable 5 cm above the floor of the GTEM cell with right angle to the axis of the GTEM cell
- front of the cable is needed to calculate the septum height in relation to the position in the GTEM (see measurement set-up side view)
- measured voltage u [dBµV] + calculated factor k [dB/m] = field strength e [dBµV/m]

2.1 GTEM cell measurement set-up (top view)



2.2 GTEM cell measurement set-up (side view)



2.3 Calculation of the transducer factor

$k = -16 * \log(f / 500\ MHz) + 20* \log (h_{septum})$

k in [dB/m]

h_{septum} in [m]

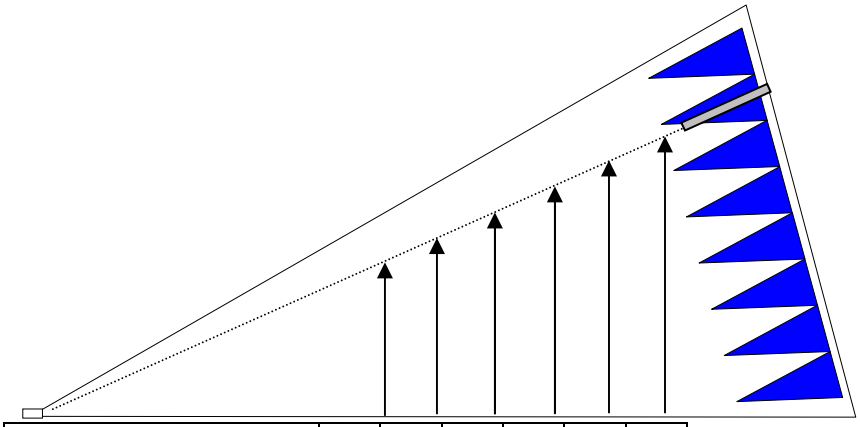
example: GTEM 1000

used septum height: h_{septum} = 1.0m

k = 75 dB/m @ 10 kHz

k = 20 dB/m @ 30 MHz

2.4 Using of the transducer factor



Position	1	2	3	4	5	6
Frequency = 50 kHz Transducer factor [dB/m]	59	60	61	62	63	64
Frequency = 500 kHz Transducer factor [dB/m]	43	44	45	46	47	48
Frequency = 5 MHz Transducer factor [dB/m]	27	28	29	30	31	32
Frequency = 30 MHz Transducer factor [dB/m]	14.5	15.5	16.5	17.5	18.5	19.5

2.5 Tables of the transducer factor for septum height 1.0 m – 0.8 m

Frequency	Septum height	Transducer factor
MHz	m	dB/m
0.010	1.00	75.2
0.015	1.00	72.4
0.020	1.00	70.4
0.025	1.00	68.8
0.030	1.00	67.5
0.040	1.00	65.6
0.050	1.00	64.0
0.060	1.00	62.7
0.075	1.00	61.2
0.100	1.00	59.2
0.150	1.00	56.4
0.200	1.00	54.4
0.250	1.00	52.8
0.375	1.00	50.0
0.500	1.00	48.0
0.750	1.00	45.2
1.000	1.00	43.2
1.500	1.00	40.4
2.000	1.00	38.4
3.000	1.00	35.5
4.000	1.00	33.6
5.000	1.00	32.0
7.500	1.00	29.2
10.000	1.00	27.2
15.000	1.00	24.4
20.000	1.00	22.4
25.000	1.00	20.8
30.000	1.00	19.5

Frequency	Septum height	Transducer factor
MHz	m	dB/m
0.010	0.89	74.2
0.015	0.89	71.4
0.020	0.89	69.4
0.025	0.89	67.8
0.030	0.89	66.5
0.040	0.89	64.5
0.050	0.89	63.0
0.060	0.89	61.7
0.075	0.89	60.2
0.100	0.89	58.2
0.150	0.89	55.4
0.200	0.89	53.4
0.250	0.89	51.8
0.375	0.89	49.0
0.500	0.89	47.0
0.750	0.89	44.2
1.000	0.89	42.2
1.500	0.89	39.4
2.000	0.89	37.4
3.000	0.89	34.5
4.000	0.89	32.5
5.000	0.89	31.0
7.500	0.89	28.2
10.000	0.89	26.2
15.000	0.89	23.4
20.000	0.89	21.4
25.000	0.89	19.8
30.000	0.89	18.5

Frequency	Septum height	Transducer factor
MHz	m	dB/m
0.010	0.80	73.2
0.015	0.80	70.4
0.020	0.80	68.4
0.025	0.80	66.9
0.030	0.80	65.6
0.040	0.80	63.6
0.050	0.80	62.1
0.060	0.80	60.8
0.075	0.80	59.2
0.100	0.80	57.2
0.150	0.80	54.4
0.200	0.80	52.4
0.250	0.80	50.9
0.375	0.80	48.1
0.500	0.80	46.1
0.750	0.80	43.2
1.000	0.80	41.2
1.500	0.80	38.4
2.000	0.80	36.4
3.000	0.80	33.6
4.000	0.80	31.6
5.000	0.80	30.1
7.500	0.80	27.2
10.000	0.80	25.2
15.000	0.80	22.4
20.000	0.80	20.4
25.000	0.80	18.9
30.000	0.80	17.6

2.6 Tables of the transducer factor for septum height 0.71 m – 0.56 m

Frequency	Septum height	Transducer factor
MHz	m	dB/m
0.010	0.71	72.2
0.015	0.71	69.4
0.020	0.71	67.4
0.025	0.71	65.8
0.030	0.71	64.6
0.040	0.71	62.6
0.050	0.71	61.0
0.060	0.71	59.8
0.075	0.71	58.2
0.100	0.71	56.2
0.150	0.71	53.4
0.200	0.71	51.4
0.250	0.71	49.8
0.375	0.71	47.0
0.500	0.71	45.0
0.750	0.71	42.2
1.000	0.71	40.2
1.500	0.71	37.4
2.000	0.71	35.4
3.000	0.71	32.6
4.000	0.71	30.6
5.000	0.71	29.0
7.500	0.71	26.2
10.000	0.71	24.2
15.000	0.71	21.4
20.000	0.71	19.4
25.000	0.71	17.8
30.000	0.71	16.6

Frequency	Septum height	Transducer factor
MHz	m	dB/m
0.010	0.63	71.2
0.015	0.63	68.4
0.020	0.63	66.4
0.025	0.63	64.8
0.030	0.63	63.5
0.040	0.63	61.5
0.050	0.63	60.0
0.060	0.63	58.7
0.075	0.63	57.2
0.100	0.63	55.2
0.150	0.63	52.4
0.200	0.63	50.4
0.250	0.63	48.8
0.375	0.63	46.0
0.500	0.63	44.0
0.750	0.63	41.2
1.000	0.63	39.2
1.500	0.63	36.4
2.000	0.63	34.4
3.000	0.63	31.5
4.000	0.63	29.5
5.000	0.63	28.0
7.500	0.63	25.2
10.000	0.63	23.2
15.000	0.63	20.4
20.000	0.63	18.4
25.000	0.63	16.8
30.000	0.63	15.5

Frequency	Septum height	Transducer factor
MHz	m	dB/m
0.010	0.56	70.1
0.015	0.56	67.3
0.020	0.56	65.3
0.025	0.56	63.8
0.030	0.56	62.5
0.040	0.56	60.5
0.050	0.56	59.0
0.060	0.56	57.7
0.075	0.56	56.1
0.100	0.56	54.1
0.150	0.56	51.3
0.200	0.56	49.3
0.250	0.56	47.8
0.375	0.56	45.0
0.500	0.56	43.0
0.750	0.56	40.1
1.000	0.56	38.1
1.500	0.56	35.3
2.000	0.56	33.3
3.000	0.56	30.5
4.000	0.56	28.5
5.000	0.56	27.0
7.500	0.56	24.1
10.000	0.56	22.1
15.000	0.56	19.3
20.000	0.56	17.3
25.000	0.56	15.8
30.000	0.56	14.5

3 Comparison screened room - GTEM-cell

3.1 Correlation of measurement results

- correlation of measurement results provides a

  linear correction factor

- correction factor can be used to convert the measured voltage of the GTEM cell into the equivalent field strength
- correction factor can be implemented in emission software for automatic field strength measurements

3.2 Advantages of the GTEM cell procedure

- simple set-up
- highly stable procedure
- very high sensitivity
- excellent reproducibility
- no problems with grounding
- can fully replace measurements using 1 m rod antenna in 1 m distance for frequencies below 30 MHz

3.3 Conclusions

- Screened room. FAR: exact observance of the measurement conditions required
- especially grounding is a critical parameter
- GTEM-cell: simple and excellent reproducible procedure
- limits:
  - change of polarisation not possible
  - large GTEM-cells for large DUT required