RF200
Antenna

User Manual

Version 3.0
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1.0 Introduction

1.1 Antenna Background

For measurement of field strength (far field emission level) an antenna is required which will act as a transducer, converting field strength (mV/m) to mV signals output down a coax cable.
Antennas to cover the wide frequency ranges required by the legislation are not simple devices! The standards call for the use of a 'tuned dipole'. Whilst this is simple to manufacture and produces a easily definable output, it will only work at one frequency, the tuned frequency. Dipoles are tuned by adjusting the length of their elements. For serious emissions measurement work, the constant retuning of the antenna for each peak of interest is time consuming, hence the introduction of 'broad band' antennas that cover a wide spectrum without the need for any retuning. These include log periodic, bi-conical, bi-log and other specialist types. All suffer from variation of sensitivity with frequency and need a correction chart so that the appropriate adjustment can be made to the spectrum. This correction chart is called the antenna factor.
The Laplace RF200 broadband antenna has a relatively ripple free antenna factor characteristic, close to the optimum.
If the antenna is used with the Laplace EMC analysers and the EMCEngineer software, selection of the RF200 item in the input menu automatically applies the RF200 antenna factor correction to the spectrum.

2.0 RF200 Broadband antenna

The broadband antenna will allow the user to detect and measure radiation over the frequency range 30MHz to 1GHz.
This is shipped in a 'knocked-down' form to ease packaging and to minimise the potential for damage in transit. Assembly is straightforward but must be done with care.
The basic design of the antenna consists of a central main beam, itself comprising two parallel aluminium sections spaced apart by insulators. Equal length pairs of aluminium rods form the antenna elements, these mounted on the main beam in order of length, the shortest at the end from which the output lead is attached. An insulating mounting block provides attachment for the stand with facilities for horizontal and vertical mounting. The non-metallic stand allows adjustment of antenna height and direction.

2.1 Antenna assembly (see fig 1)

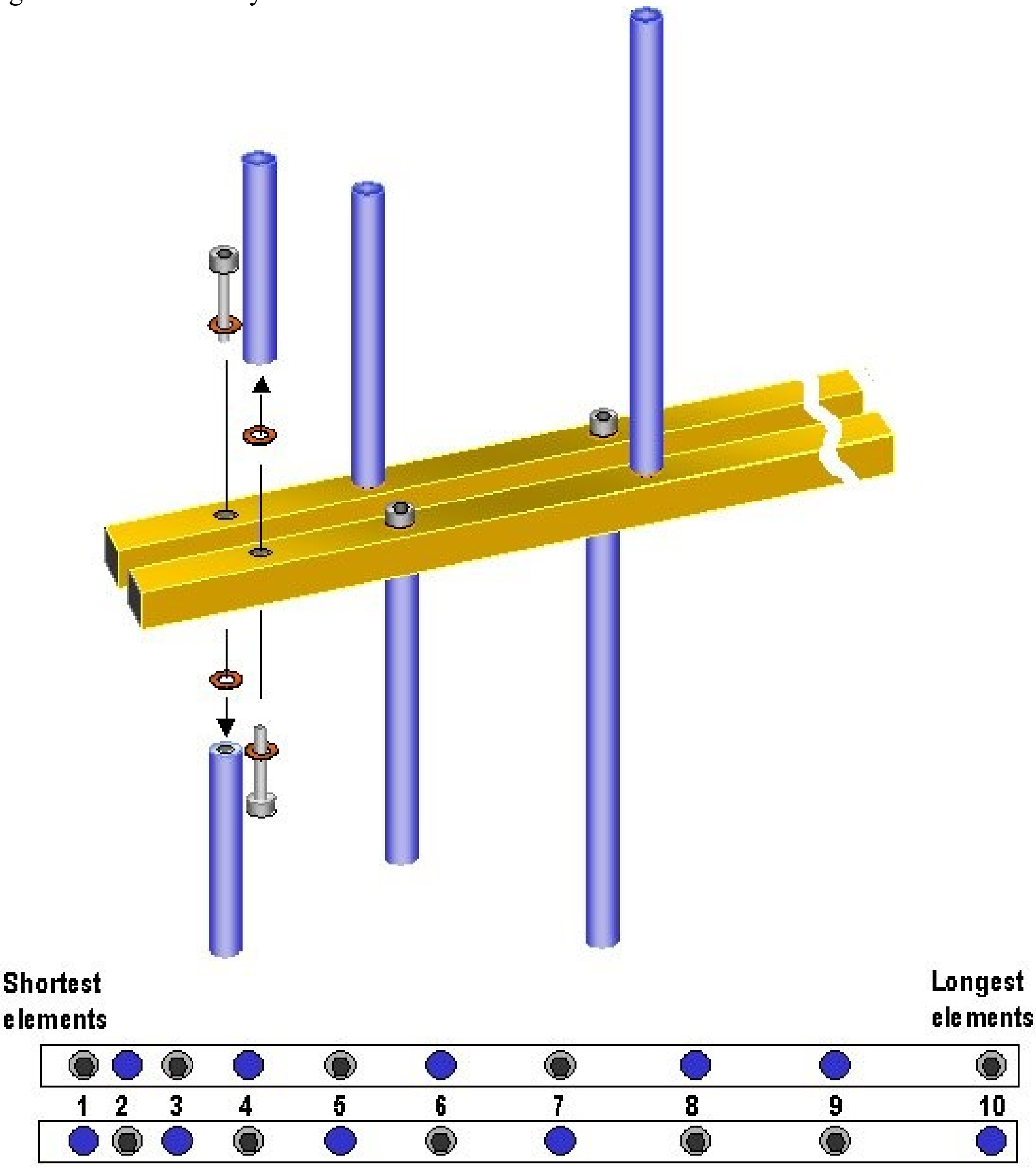
1. The aluminium alloy elements are secured to the central beam using the M4 bolts and washers provided. An M4 hex driver is also included to facilitate assembly. These elements are mounted in equal length pairs with the shortest at the end of the central beam where the output cable is attached. There are two copper crinkle washers with each bolt. Ensure that one washer is under the bolt head and the other is under the antenna element. Tighten the bolts until the crinkle washer is flat. Do not overtighten as this may distort the beam. Alternate the element direction as shown in the diagram

so that for each side of the central beam, the elements alternate up, down, up, down...etc**. until element 9 which is out-of-sequence and is mounted same side as element 8**. Element 10 is alternate to element 9 as shown in Fig 1.

3. The number of elements (10 pairs) should match the number of hole pairs along the central beam.

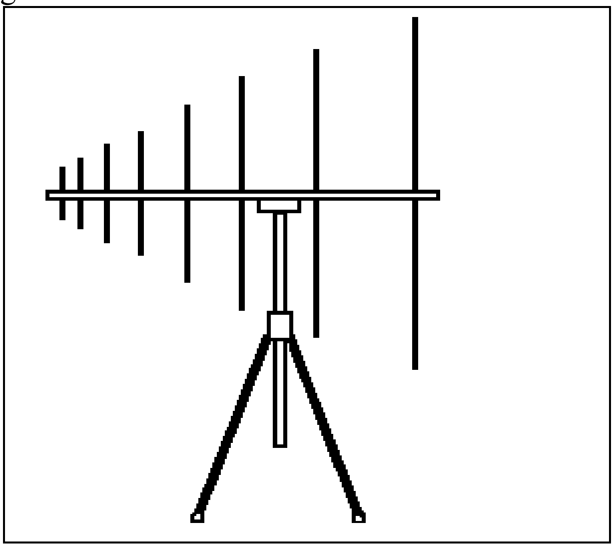
4. A pre-drilled plastic block is supplied to form a central mounting block and pre-amp support. This is screwed to both beams using the supplied nylon screws.

Fig 1 RF200 Assembly



RF200 Stand assembly

Fig 2 RF200 stand



This is supplied as a central vertical support fitted with a leg attachment moulding and three legs.
The legs are a push fit into the leg attachment moulding.
The vertical support has a friction slide fit in the leg attachment moulding so that the antenna can be adjusted in height over the full length of the vertical support.

The antenna is located on the stand by locating the central support block on the top of the vertical support in either the horizontal or vertical polarisation position. Nylon bolts are provided so that the antenna can be clamped in position
If used outdoors in strong wind conditions, the stability of the antenna can be considerably increased by filling a bag with sand, soil or stones and supporting it by string tied round the leg attachment moulding.

2.2 RF200 in use

Connect the SA1020 pre-amplifier directly to the antenna output lead and secure the pre-amp to the central support block with the velcro strips. Ensure that the connection to the antenna is made to the input of the pre-amplifier. It is easy to get the amplifier wrong way round!!
Point the antenna, sharp end forward, at the UUT. Note that the antenna is not particularly directional but full sensitivity is maintained over a wide angle either side of ‘dead ahead’.
The reference point for the measurement of EUT – Antenna distance is the central mounting point, where the vertical pole meets the horizontal main antenna beams.
The height of the antenna can be changed by sliding the vertical support up or down within the leg attachment moulding. If this friction fit is too slack or tight, **slightly** adjust the nylon bolt to suit. Note that antenna height may be a critical factor in obtaining valid results. See section 4 on Ground Plane.

2.3 Antenna Factor

The sensitivity of any antenna will vary with frequency. i.e. it will be more sensitive at some frequencies and less sensitive at others. For EMC purposes a correction table is used from which the output can be related to dBuV/m field strength. This is called the Antenna Factor.

The SA1000 Windows software has the antenna factor for the RF200 broadband antenna ready installed. Selecting this item in the INPUT menu automatically applies the appropriate conversion to read out in absolute field strength.

WARNING: Although the conversion is valid, the field strength measured by the antenna is subject to your test site conditions and configuration and may be subject to gross errors. Reception of emissions radiated from the UUT depend on the test conditions, the test site, reflections, ground plane, background radiation, UUT to antenna distance etc..etc.. Be very wary about relating field strengths to limit lines unless you have some known test results to act as a reference.

Fig 3(a) RF200 Antenna factor, linear frequency scaling.
Note. Antenna factor includes SA1020 Pre-amplifier and 5 metres co-ax cable.

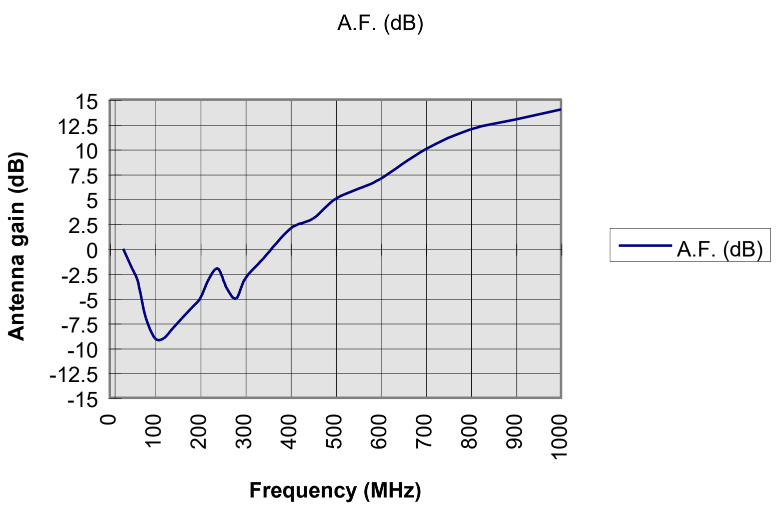
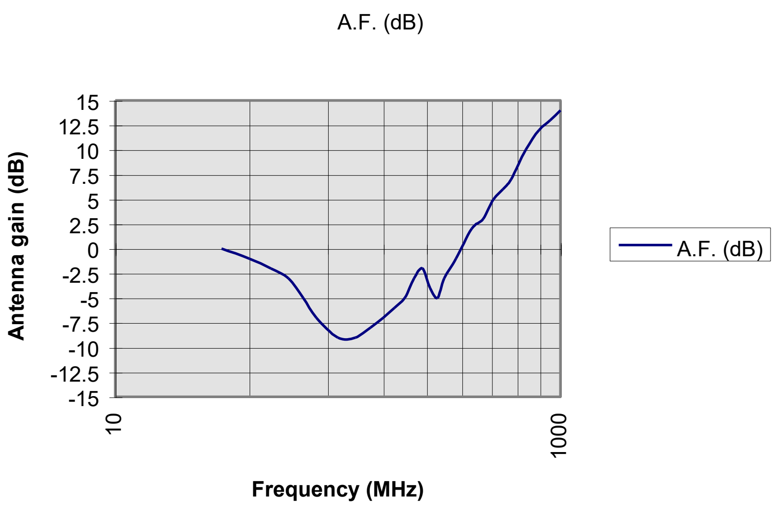


Fig 3(b) RF200 Antenna Factor, Log frequency scaling
Note. Antenna factor includes SA1020 Pre-amplifier and 5 metres co-ax cable.



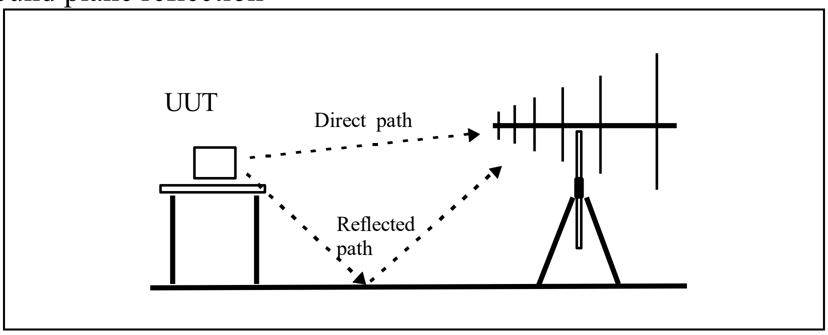
Antenna Factor tabular data

Freq(MHz)	A.F. (dB/m)	Freq(MHz)	A.F. (dB/m)	Freq(MHz)	A.F. (dB/m)
30	0	220	-3	460	4
40	-1	240	-2	480	5
50	-2	260	-4	500	5
60	-3	280	-5	550	6
70	-5	300	-3	600	7
80	-7	320	-2	650	9
100	-9	340	-1	700	10
120	-9	360	0	750	11
140	-8	380	1	800	12
160	-7	400	2	850	13
180	-6	420	3	900	13.5
200	-5	440	3	950	14
				1000	14.5

3.0 Ground plane

In general, any UUT will emit radiation in all directions. Some of this will impinge on the ground which will partially reflect this radiation.
When measuring emissions in the far field, the signal received by the antenna will comprise a direct signal and a signal which has been reflected from the ground. (Assuming that the test site has been chosen so that no other reflections are present).
The amount of this reflected signal depends on ground conditions and may vary very considerably in amplitude. On 'soft' ground such as earth (soil) the reflection will vary from day to day as conditions change. This means that the integrity and consistency of the results will be variable. To overcome this problem, the standards require a test site to have a metal ground plane consisting of a continuous metal sheet (or equivalent) under the UUT and between the UUT and the antenna. This gives a consistent 100% reflection. This is in one sense 'worst case' because the effect of the reflection will be maximised, but at least it will be consistent.
The effect of the reflection will depend on frequency and the difference in path length between the direct path and the reflected path. If this difference is equal to half a wavelength at the frequency of interest, the two signals will be 180° out of phase and will cancel, producing up to 20dB reduction in signal strength.

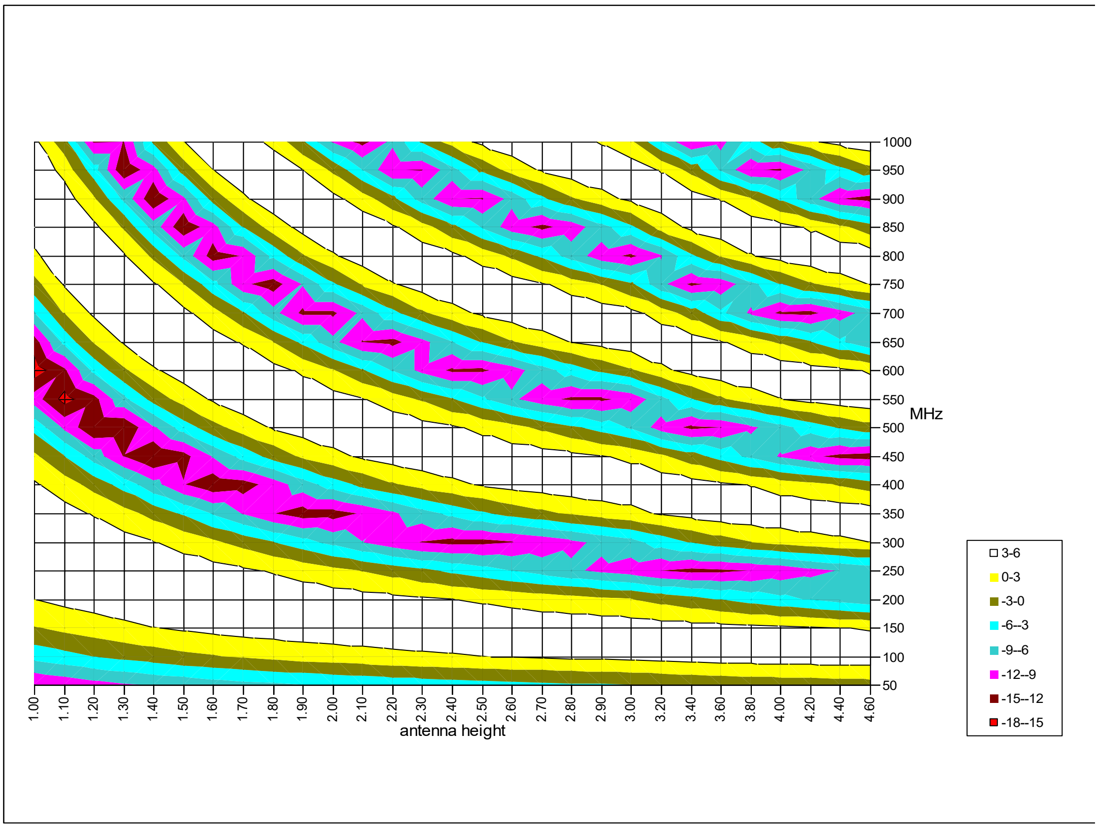
Fig 4 Ground plane reflection



To overcome this effect, the standards call for the antenna to be mounted on a mast so that it can be varied in height over a range of 1 to 4 metres. For each frequency there will be a height at which the two signals are in phase and additive. This is the height at which that frequency is measured.
Fig 5 shows the relationship between frequency, antenna height and signal gain/attenuation. The white areas correspond to gain and the dark areas represent attenuation.
If using an open field site on dry soil, the reflection will be small and the gain/attenuation effect will be minimal. However, if any metal surface is in the vicinity (filing cabinet for instance) this chart gives some idea of the consequences!
Note that the chart is correct for the conditions listed only. If for instance the polarisation is changed to vertical the plot will completely change.

Fig 5 Ground plane effect

Conditions: Product height: 0.8m
Antenna distance: 3m
Polarisation: Horizontal



Ground plane: Metal sheet (ideal)

4.0 Test Site Calibration

Any area or test cell used for far field radiation testing should be calibrated. Purpose made cells such as a G-TEM cells are supplied ready with a calibration sheet which defines the characteristic relationship between UUT emissions and cell output vs frequency.

If using a an open field test site, this should also be calibrated. The ground plane reflection alone can have a significant effect on the test results. To calibrate a site, a known source should be used. Laplace can supply a calibrated source, complete with calibration curves, which is specifically designed for the calibration of sites and antennas. Contact Laplace for details of this ERS (Emission Reference Source). An alternative for achieving a rough calibration is to use a product with known emissions (i.e. one which has already been tested at a test house) on your test site under exactly the same conditions as applied during the test house measurement. By correlation of your results with the test house results, an approximate calibration of the site can be derived. Note that if the site is outdoors, it will need a calibration check every time it is used because weather conditions can affect the site significantly.
Drawbacks to this technique are the problems of obtaining consistent emissions from a product and the fact that the correlation can only be applied at those frequencies for which emissions exist.

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