ERS
Emission Reference Source

Application notes
and
EMCEngineer software guide

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ERSupgrade.pdf

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8.4 ERS—Site Calibration Function

When measuring radiated emissions (whether on an OATS or test chamber) the dominant source of measurement uncertainty will be the test site. Even on a perfect OATS, the effect of the ground plane will cause errors of up to +6dB and −15dB on a 3m site, unless height scanning is performed. (That is the adjustment of antenna height between 1m and 4m to a position where the direct path and the reflected path from the ground planer are in phase, thus producing a maximum emission signal).

If we assume that we are unlikely to have the space, budget or resources to create a truly compliant OATS, or to install a really good test chamber, then some a method or technique that overcomes this issue and reduces the measurement uncertainty to an acceptable level would be extremely useful.

Ideally, we need to be able to quantify the errors. If they are known, then they can be corrected. The EMCEngineer software now has the ability to do exactly this. The method involves the use of an ERS (Emissions Reference Source). The ERS is a very stable source of emissions that generates a signal every 2MHz from 30MHz up to 1000MHz. Each signal has been calibrated on a 3m OATS, traceable back to NPL in London. So it is a transfer standard Each is supplied with a full set of data comprising the level of each 2MHz signal as measured at NPL. So if the site that you are using was as good as NPL, then the measurement of the ERS emissions on your site would be the same as the ERS calibration data.

Inevitably, the results would not match, but the differences between your measurement and the calibration data would define the site errors, and this data can be then used to correct the measurements from your EUT. Not only does this correct your site, but it avoids the need for height scanning, and the need for a ground plane. The correction also includes any effects due to antenna, cable, analyser/receiver, thus providing a true end-end (EUT to display plot) function. It is important to note that once the calibration has been performed, the site conditions and arrangement must remain fixed. Should anything change or move, the calibration becomes invalid and will need to be repeated.

The process can be done separately for vertical and horizontal polarisations.

The general procedure is prompted by the software.

8.4.1 Summary of the Calibration Process.

- This procedure first checks for the emissions from the ERS in the band 500MHz—1000MHz. This is to establish an exact match between the analyser and the ERS in terms of frequency. (the potential worst case frequency accuracy of the ERS and the analyser are each 80ppm. That equates to 160KHz at 1000MHz, which is outside the +/- 60KHz RBW of the Analyser).

- On completion of the initial phase, the analyser knows exactly where the ERS peaks are, and can now perform measurements of each peak from 30MHz upwards. Because we are only measuring these 2MHz series of peaks, not the whole spectrum, the scanning is rapid. To ensure accuracy, the scan is performed 8 times and averaged. Then the ERS is switched off and the scanning repeated to identify the ambient level at these frequencies.

- The software now has a full set of measurements of each peak from the ERS, as measured on the test site. It also knows what the results should be (from the calibration data). From this, the software can now calculate the correction factors which would make the ERS result look the same as the ERS calibration data. These factors can be viewed in the Information window. These correction factors can be saved for later use.

- The whole process can be repeated for the other polarisation.

- On completion of this site calibration process, the ERS is removed and the EUT placed at the same location, ready to be tested.

- The emissions from the EUT are then measured as described in the previous section (8.3). The end result should be an ambient (store) trace and a current trace which includes EUT + ambient emissions.

- Switch on the difference trace. Ensure that the Difference trace mode is set under the Processing menu to 'Difference : Emissions'.
- Under the ERS menu, select Apply Correction : vertical or Apply Correction : Horizontal. as appropriate.
- The difference trace will now be 'corrected' and the levels will appear as though they had been measured on a perfect test site. Note that the corrections can be very significant!

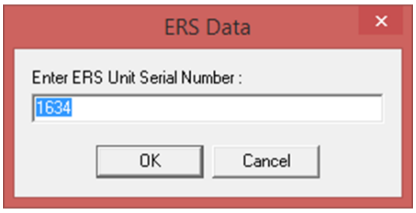
8.4.2 Detailed Procedure

<u>Preliminary stage….</u>

First, the calibration data for the ERS must be loaded into the software. This needs to be done only once. It will remain 'on file' thereafter.

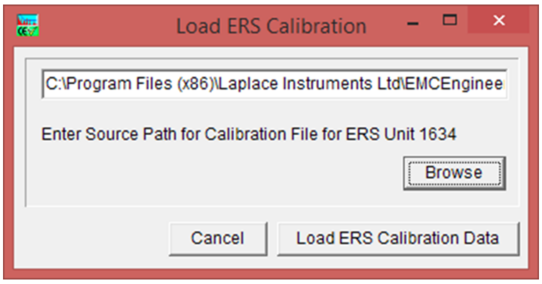
Select 'ERS' from the main menu bar.

Select 'Install ERS Data'.



Enter the serial number of the ERS as prompted…….

Note: There is a calibration validation test that can be applied, see later. This involves the use of an artificial calibration file which has the ERS serial number 0060*. If this validation test is to be instigated, enter '0060' and select the '0060' files in the next step.



Use the Browse button to locate the ERS data files. They are normally supplied on USB stick or CD with the ERS. The files will be in the form nnnn.hor and nnnn.ver where nnnn is the serial number of the ERS and the .hor and .ver files are the horizontal and vertical files respectively.

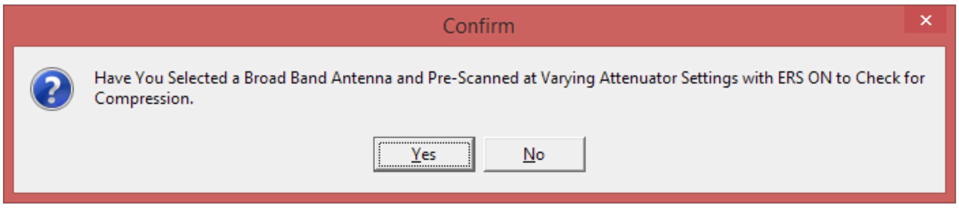
A message will be displayed to acknowledge the successful loading of the ERS data.

<u>Calibration stage 1….</u>

The test site should be established with the antenna located, the location of the EUT established and the site kept as clear of metallic objects as possible. Once the site is settled, the ERS calibration phase can begin. Note that both vertical and horizontal calibrations should be acquired.

Select 'ERS' from the main menu bar.

Select 'Calibrate Site'.

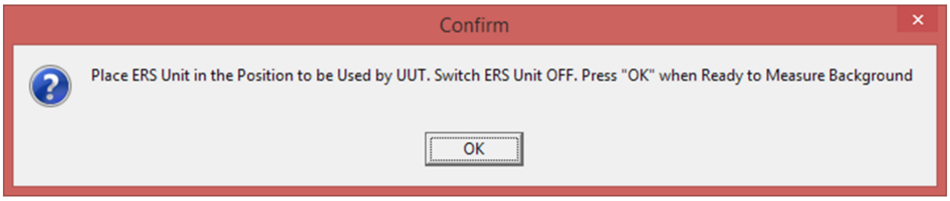


A message will appear to confirm that you have checked the signal level that will be input to the analyser when the ERS is running. Due to the strong signal from the ERS, an attenuation setting of 20dB will be required on a typical site.

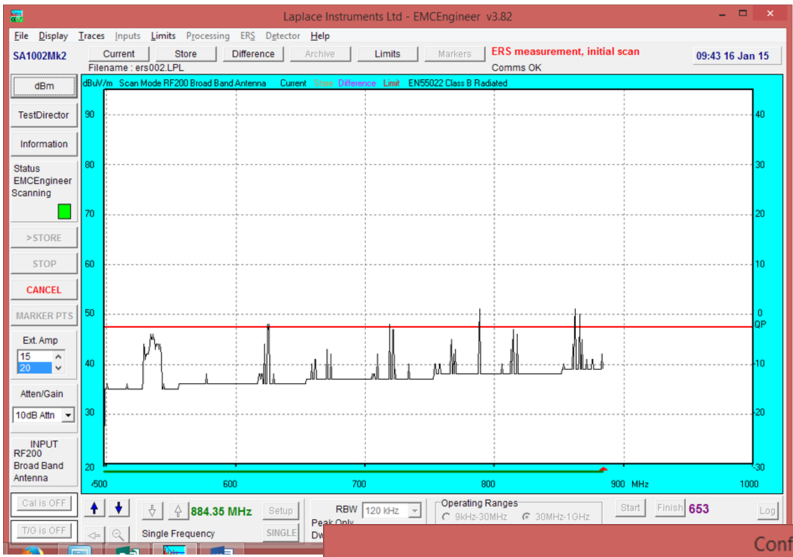
The ERS serial number should be entered. (Either nnnn or 0060)

*	If the 0060 files are missing, they can be downloaded from our web site (www.laplace.co.uk). Go to the 'Downloads' page and select 'Software' then 'ERS—50dBuV/m flat files'.

The software will then prompt…..



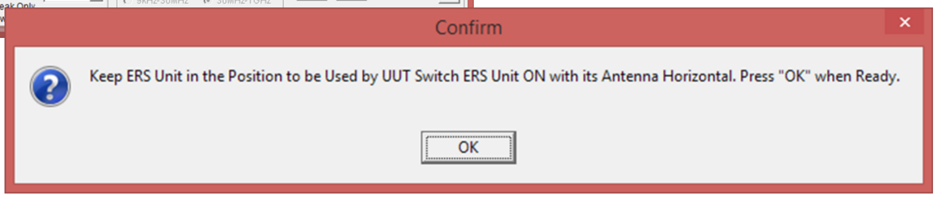
Note that at this stage, the ERS is switched off, but remember to ensure that any pre-amp is switched on!



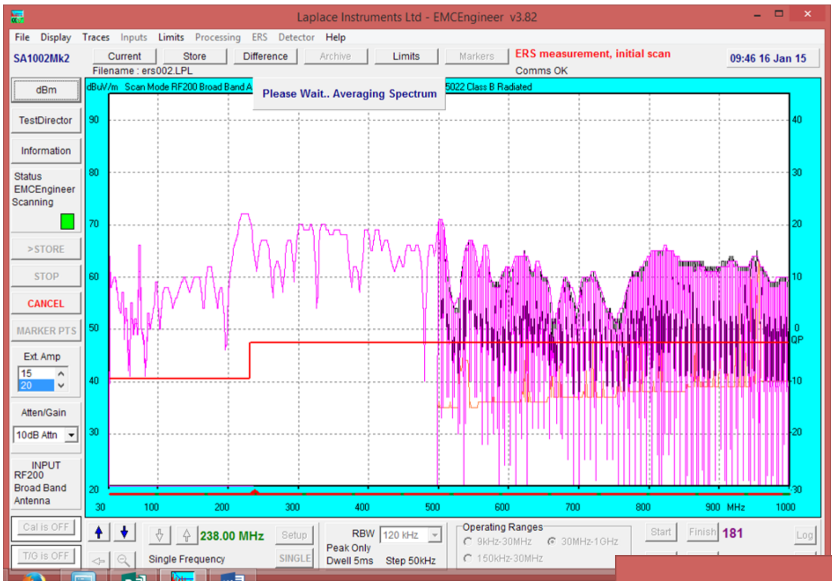
After the second reminder to keep then ERS switched off, the preliminary scan will be taken….

The span is from 500MHz to 1GHz and initially shows just the ambient signals.

On completion of this scan, the software will prompt for the ERS to be switched on.



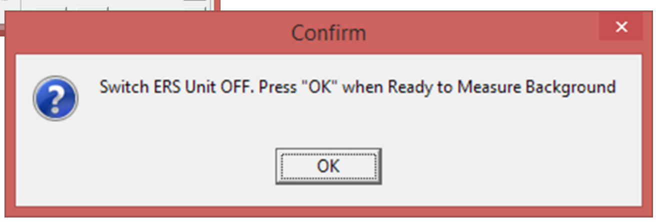
The system will now repeat the scan, displaying the ERS signals. From this scan, the precise frequency of the ERS will be determined. The analyser is now able to precisely measure all the ERS signals from 30MHz upwards.



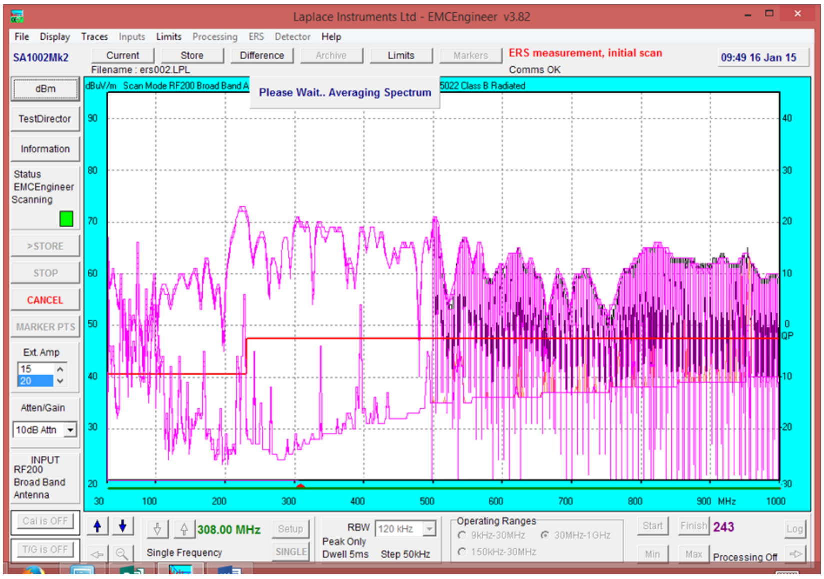
<u>Calibration stage 2…</u>

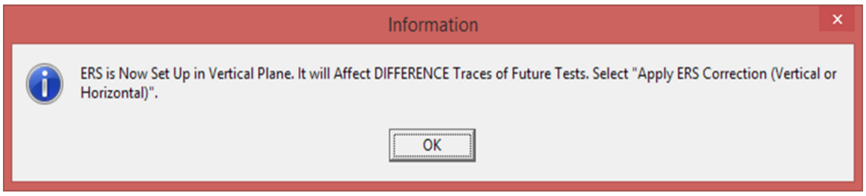
In response to the prompts, confirm that the ERS switched on. The system will now measure the individual ERS peaks over the whole range 30MHz—1GHz. To improve accuracy, the scan is repeated 8 times and averaged.

The system will now prompt for the ERS to be switched off.



When the ERS is switched off, click OK and the scans will be repeated to check the ambient levels at precisely the same frequencies.





The software has now acquired all the information necessary to calculate the correction factors for this site, this positioning of antenna and EUT, and this polarisation.

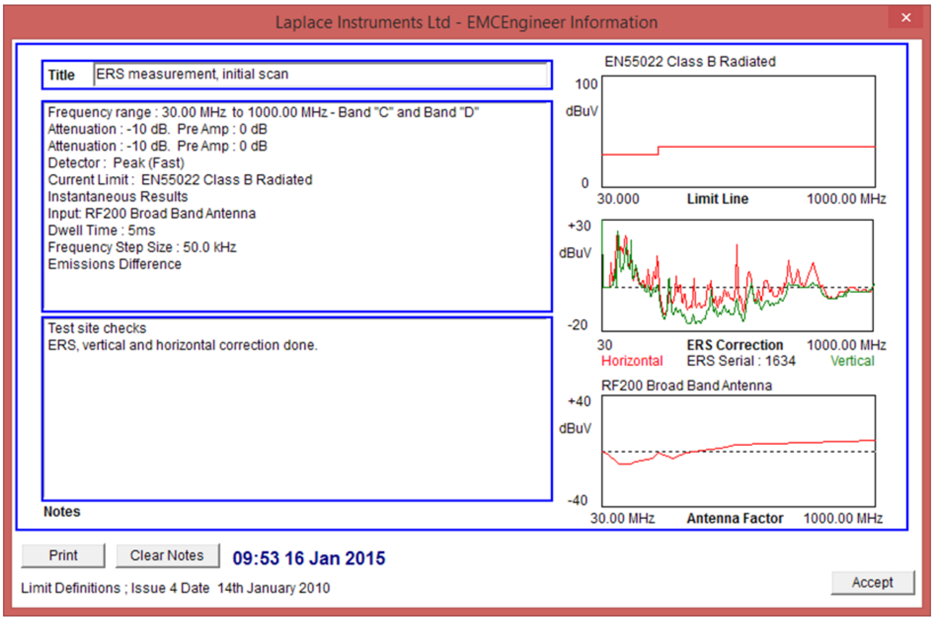
<u>The calculation</u>

If we take just one (any one) frequency within the range 30—1000MHz, the software knows what the ERS level was (we just measured it) and it knows what level we should have measured on a perfect site (from the ERS calibration file). The difference is the required correction factor. So, if we measured 54dBuV/m on our site, and the ERS data indicated 61dBuV/m, then the correction factor will be +7dB.

We can see this plotted in the 'Information' screen……….

The central thumbnail plot on the RHS shows both the vertical and horizontal correction data.

It can be seen in this case, that the correction is generally positive (ie, the site was reading low) for the lower frequencies, correction is low in the mid frequency band (so the site must have been reading high here) and around zero correction at the top end. Note that every site will be different!



Application of the correction.

This correction data only applies to signals originating in the region of the ERS. It will apply equally to signals from the EUT, provided the EUT position matches that of the ERS. The correction data does not apply to ambient or background noise. For this reason,

the correction data is only applied to the difference trace.

The difference trace being the result that has had the ambient (background) noise removed, just leaving the emissions from the EUT.

To apply the correction, first display the difference trace then from the main menu, select ERS…. Apply correction (vertical or horizontal). The difference trace will now be corrected.

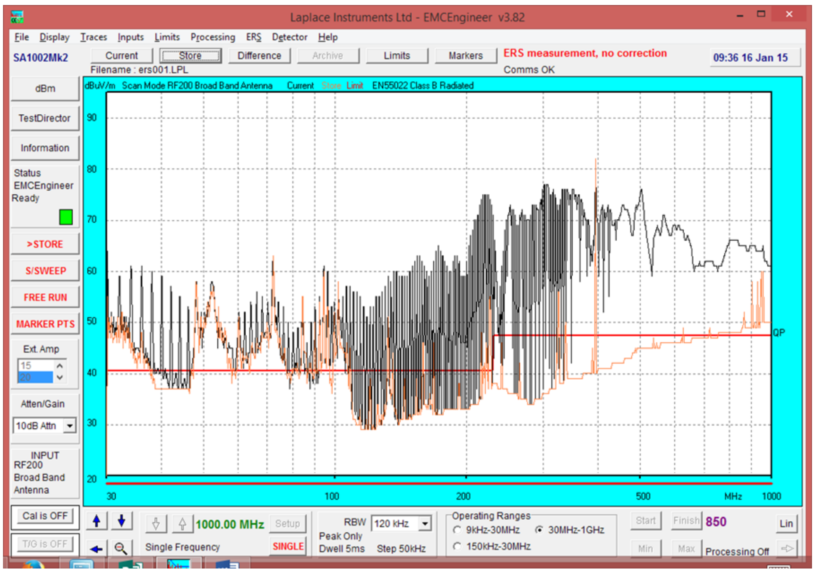
8.4.3 Site integrity check.

We can check the effectiveness of the calibration process by now measuring the emissions from the ERS. We can further improve ease of interpretation if we had an ERS with a completely flat output level. This would be a totally artificial instance, but it helps the visual study of the result. Your ERS will have a 'proper' calibration file, nnnn.hor and nnnn.ver, as described earlier. The spectrum of these emissions are shown in the ERS user manual. If we did the calibration with these files, and then measured the ERS and applied the correction, the resulting plot should look very similar to the plots shown in the manual. Checking the correlation of these plots with what is shown on screen is not particularly easy… but if the expected plot was a constant level across the spectrum it is easy to judge the performance of the system.

On the CD or USB stick there are two sets of files. nnnn.hor and nnnn.ver, plus 0060.hor and 0060.ver. These 0060 files have the same level (60dBuV/m) across the whole spectrum. If these files are loaded instead of the 'real' files, you can obtain a very detailed view of the effectiveness of the whole process.

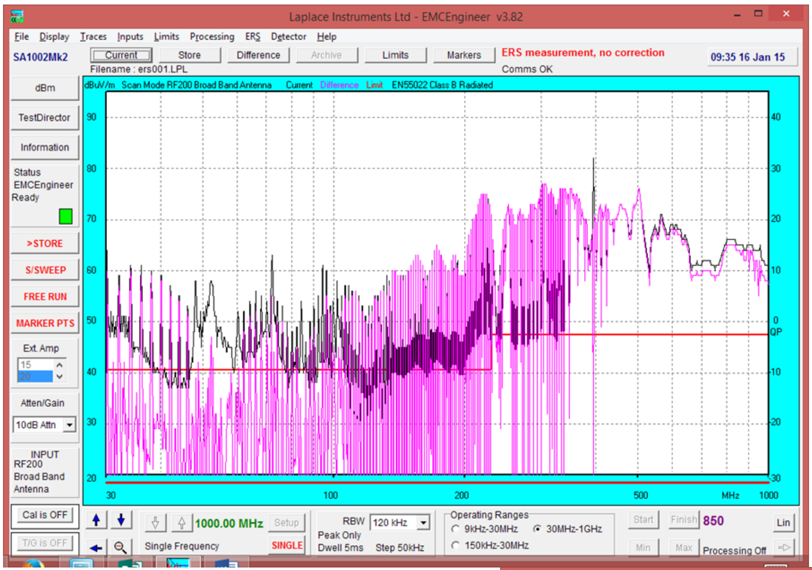
It must be emphasised that for real EUT correction, the 'real' data files must be used. The 0060 files are totally artificial and are only provided to enable you to study the effectiveness of the correction feature.

The remaining screen shots are based on the use of the 0060 calibration files.



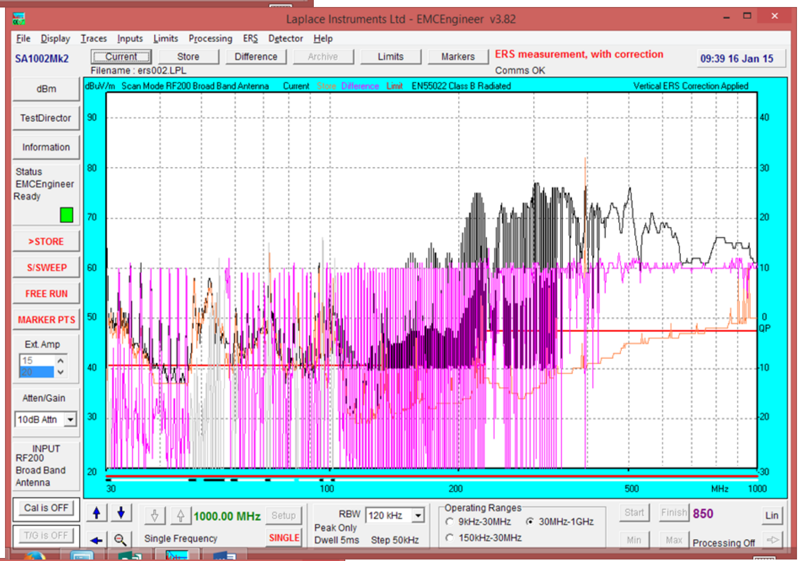
This shows the measurement of the ERS using the standard technique.

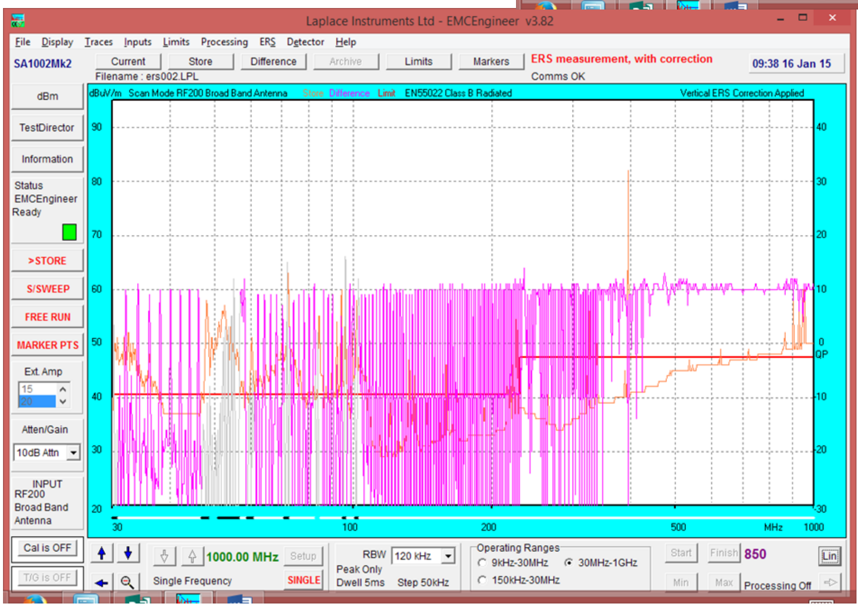
Initially the ambient is measured and transferred to the Store trace, and then the EUT +ambient levels in the current trace.



Difference trace switched on. Due to the low levels of ambient, the difference trace closely matches the current trace over most of the spectrum.

ERS correction now switched on. Because the calibration file used (0060) was set at 60dB across the whole band, the result should be a flat line at 60dBuV/m. The corrected difference shows how effectively the technique works, with generally excellent correlation to the 0060 calibration levels across the whole range.





For clarity, the current trace can be switched off to make the difference trace easier to see.

There are some frequencies at which the integrity of correction is not good. For example, in the band 50—60MHz. There may be a particularly low level from the ERS, or they may coincide with strong ambient transmissions. These frequencies are identified by a change in colour of the difference trace, and black 'markers' shown on the white bar running across the bottom of the plot area. This indicates frequencies at which the correction is not reliable.

Also, note that in the 900—960MHz area, the correction is not right. These frequencies are commonly used by mobile phones, which by their nature, are intermittent. It is almost certain that the bands were in use during the calibration process, but not when the final scan was made. In normal practice, averaging would be used during any EUT scans, specifically to reduce the incidence of this condition.

8.4.4 Limitations

The method assumes that the ERS and the EUT sources are radiating from the same position in space. With a small EUT, that is not a problem. However, for large EUTs or EUTs with cables that are contributing to the emissions, then this may be an issue. Also, the ERS is essentially a point source whilst the EUT emissions may be distributed, eg along a cable. The sensitivity to location will depend on how 'confined' the test site is. By 'confined' we are relating to the amount of metalwork, cables, framework, etc… in the immediate vicinity. If the site is reasonably 'open', ie minimal reflective surfaces in the vicinity, then location is not critical. However, if the site is 'confined' then location becomes more important. It would be worth checking 'site uniformity'. To do this, perform the '0060' calibration with the ERS located centrally in the area to be occupied by the EUT. The check scan will doubtless provide a flat line result as shown above. Now move the ERS to peripheral locations and repeat the check scan. This will show the variance of readings across the EUT volume. If the degree of variance is unacceptable, then either:

* find a better site.
* Adjust the site (relocating antenna and/or EUT location. Moving any metallic items in the vicinity.
* Use a near field probe around the EUT to locate the position of the source of emissions, then ensure that the ERS is located at that particular location in space. Often, the source is from a cable. Locate the ERS at a position that corresponds to the midpoint of the cable.

In any circumstance, the use of the ERS demonstrates the characteristics of the site, and thus provides a measure of the integrity of the measurements of the EUT.

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