To: 3P Customers and Business Partners

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3P Newsletter No. 3/2006

Return Loss of Cables-1

Return loss proved to be the critical parameter for 1 Gigabit Ethetnet cabling, and caused many problems for installations, installers, patch cord producers and especially cable producers. Return loss was until then not a critical parameter as lower data rate cabling had other weaknesses. It therefore caused a major impact to the cabling industry when return loss became critical.

The return loss turmoil was felt by everyone working with cabling, but maybe the cable industry was the most affected. During the years after release of 1 Gigabit Ethernet, return loss of cables became significantly improved and has today normally a performance level passing requirements with a safe margin. (A parallel situation exists today with the birth of 10 Gigabit Ethernet for which alien crosstalk will create similar or probably even more turmoil on the cabling market).

However, in spite of the generally significant improvement of return loss of cables, awareness still needs to be maintained about this parameter. 3P has also today many requests from the market concerning cable return loss issues related to

- box packaging
- bending / coiling
- mean impedance
- degradation of cable return loss by connecting hardware
- mechanical stability of patch cords
- wall mounting of home cables

These issues are discussed in the present line of 3P Newsletter, the first treating box packaging related issues.

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General

Return loss of cables may be critically affected by repeated deformations of a cable. It is that simple and that complex. The deformations cause change of impedance in the deformed points which again causes reflections of signals between deformed points. One deformation is consequently not so critical, while many deformations with the same distance between them is a worst case situation, i.e. repeated reflections. A very construction-stable cable will not be critically affected even by worst case regular deformations, while other cables may get totally failing performance.

Regular deformations may occur during a bad production (not usual), during too hard strapping by installers, by wall mounting around sharp corners, by wall stabling and by the box packaging.

Box Packaging and Return Loss

In the present context box packaging does not cover a box with an internal drum, which normally does not degrade return loss performance. It means a packaging where cable crosses one time for each winding (can be easily verified by looking into the box).

For each winding the cross over point will potentially cause an indentation on the cable and in some cases you may see the indentations clearly on the cable surface when you pull out the cable, i.e. marks with a regular distance. Distance between indentations will be larger for the last pulled cable length (and with less extent of indentations) and shorter for the first pulled length (and with more critical indentations). This is caused by the smaller diameter for the inner windings and the higher cable load on the cable crossings. Typically the effect will be a return loss peak in a narrow frequency band at approx. 60 - 80 MHz. Again it should be stressed that this box packaging effect will not be seen for the constructionally most robust cables.

The behavior of this potential problem is characterized by:

- Longer storing time of the box increases the problem
- Higher storing temperature of the box increases the problem,

but also for **unscreened cables**

- Time passed after installation will most often improve performance (healing process during the first days after installation may be significant, but never total)

and for **screened cables**

- Pulling of the cable in the installation will most often improve performance again (healing process by pulling may be significant, but never total. The time after installation is not significant for the healing process of screened cables)

The difference between the healing process for unscreened and screened cables is due to the screen. It will maintain the cable deformations preventing the normally experienced relaxation of the plastic materials with time, but the normal bending / stretching of the metal foil during installation pull will relax the deformations immediately.

The effect of the healing process is shown for a screened cable in attachments "figure1 and figure 2" for the same cablw before and after installation pull, respectively. It may be seen how the return loss is improved from failing to safe passing after an installation pull.

The return loss characteristic behavior discussed above is realised by the standardisation bodies, but until recently no special focus on the very special box packaging problem was included in any cable standards. However, recently a series of CENELEC home cable standards includes for the first time this point (EN 50441-x, June 2006). The text reads for all electrical performance requirements:

For unscreened cables: "In case of box packed cables, the performance requirements apply after storing the sample for three days after removing the cable from the box"

For screened cables: "In case of box packed cables, the performance requirements apply after carrying out a tensile test according to EN 50289-3-9 with the pulling strength being between 10 N/mm^2 and 50 N/mm^2" copper conductors.

This way of performance characterising box packed cables is precisely what is the basis of 3P qualification of box packed cables and our recommendations to the market.

Most producers are believed by 3P to report performance as measured from the external end of the box. This is as earlier discussed a best case measurement, but frequently corresponds with the healed performance of the cable. By coincidence you therefore often actually get the healed performance data even though the measurement is carried out in the box. However, you cannot be sure and anyone trying to measure from the inside end may unneccessarily reject cable due to a return loss "box peak".

This nature of box packaging failure and healing makes it very important to realise that performance in a box is **not** what you get after installation, and consequently that rejection of a cable based on box measurements is not meaningful with respect to performance of the installation. Therefore, producers should always base their internal testing on performance out of the box (tested in the box, but relating the result to out-of-the box healed improvement) unless customer requirements specifically refer to performance in the box.

After pointing at the benefits of out-of-box storing (for unscreened cables) or installation pulling (for screened cables) it should be stressed that these operations will only provide improved performance if the return loss spike is coming from the box packaging. For cables having low or medium return loss performance there will be a number of return loss spikes with generally low or negative headroom, i.e. not only one spike clearly separated from a generally fine performamce. Such spikes will generally not be affected by any out-of-box handling, which is therefore not in this case recommended by 3P or of any value. Attachment figure 3 shows a return loss trace for a cable having generally poor return loss performance and for which out-of-box handling is not meaningful.

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The return loss discussion of performance in connection with bending / coiling, mean impedance, degradation of cable return loss by installations, mechanical stability of patch cords and wall mounting of home cables will be discussed in the next 3P Newsletters.

Yours sincerely,
3P Third Party Testing

Poul Villien

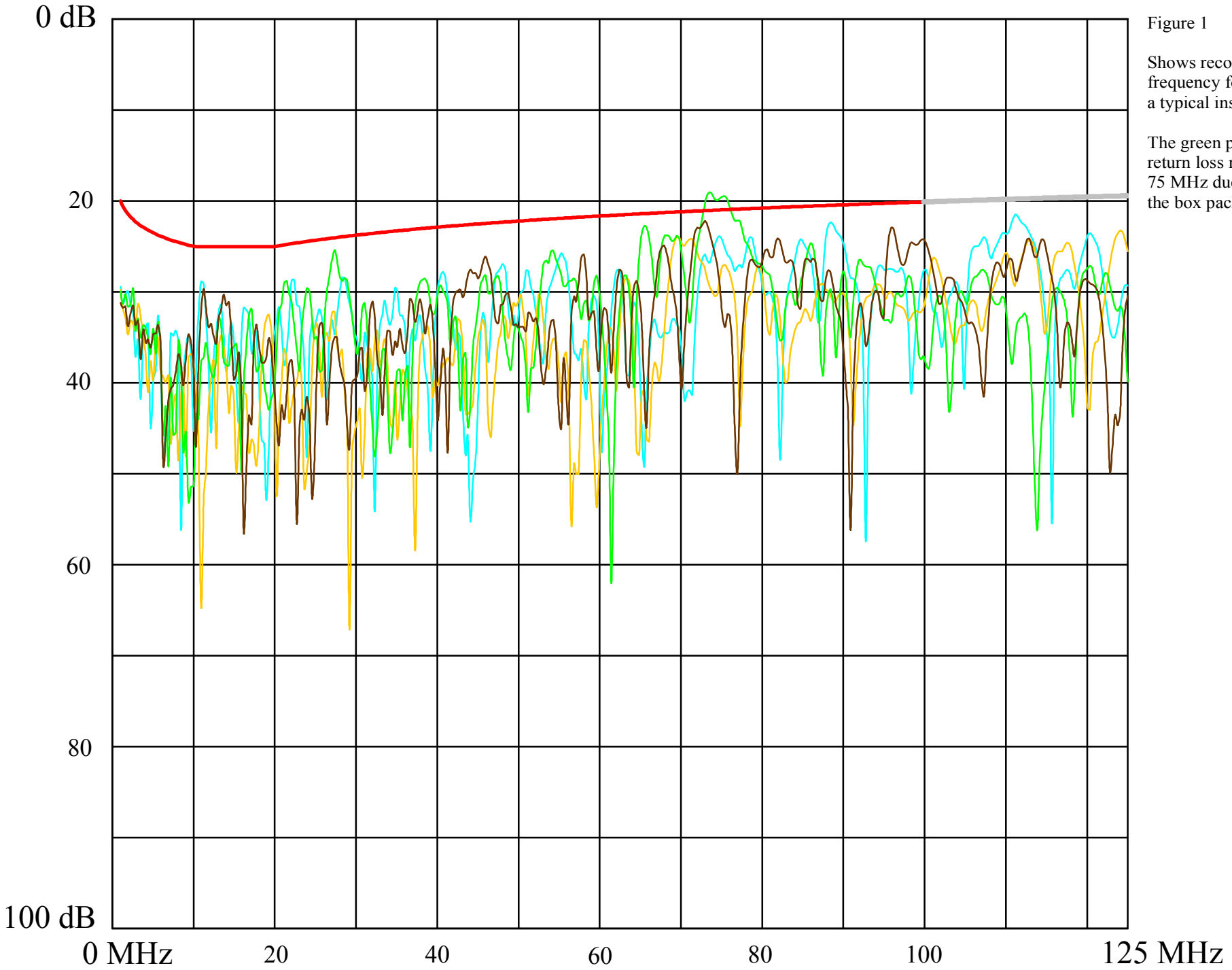

Figure 1

Shows recordings of return loss with frequency for a screened cable before a typical installation pull.

The green pair of the cable fails return loss requirements at approx. 75 MHz due to return loss spike from the box packaging.

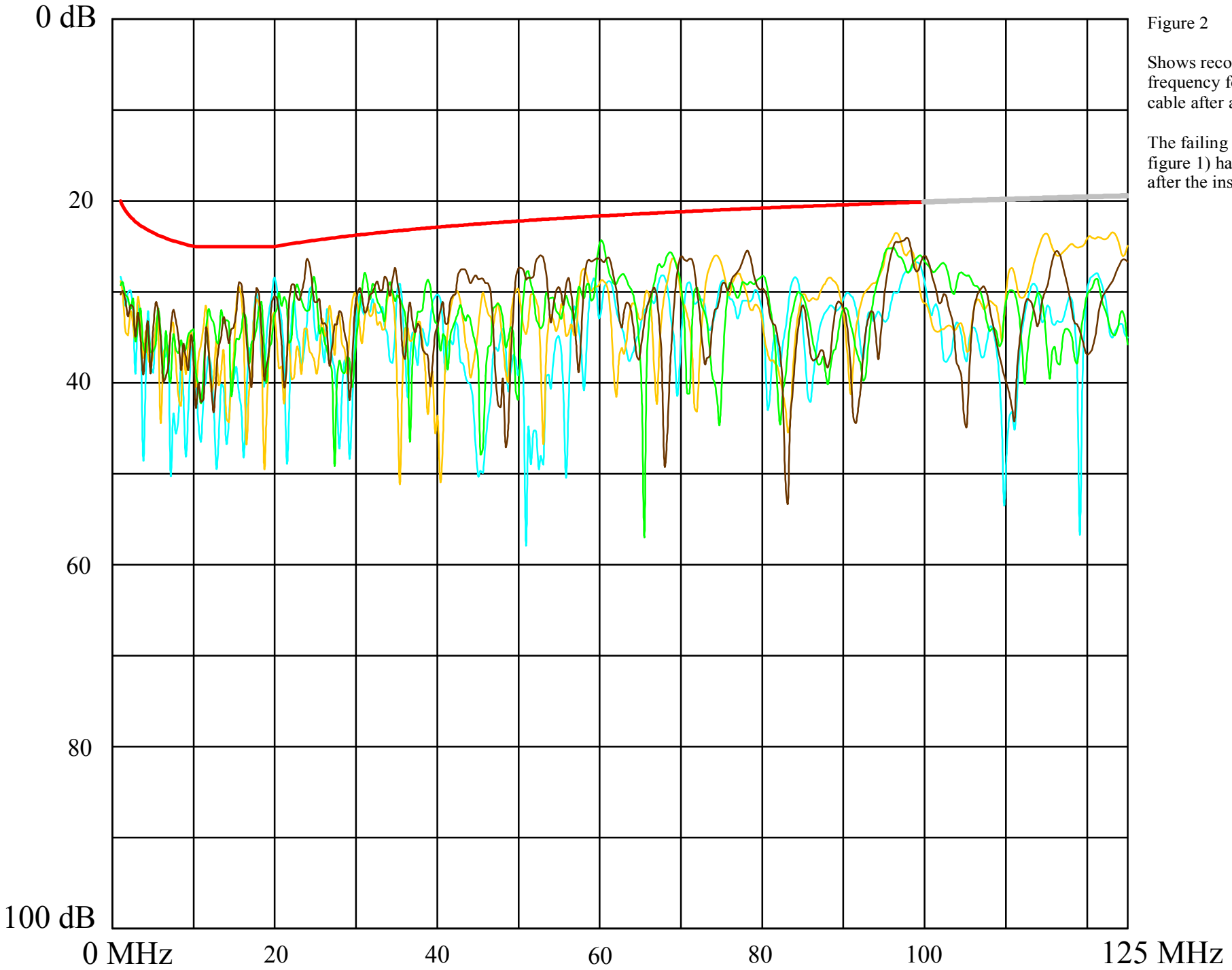

Figure 2

Shows recordings of return loss with frequency for the same screened cable after a typical instalation pull.

The failing return loss peak (see figure 1) has improved to a safe pass after the installation pull.

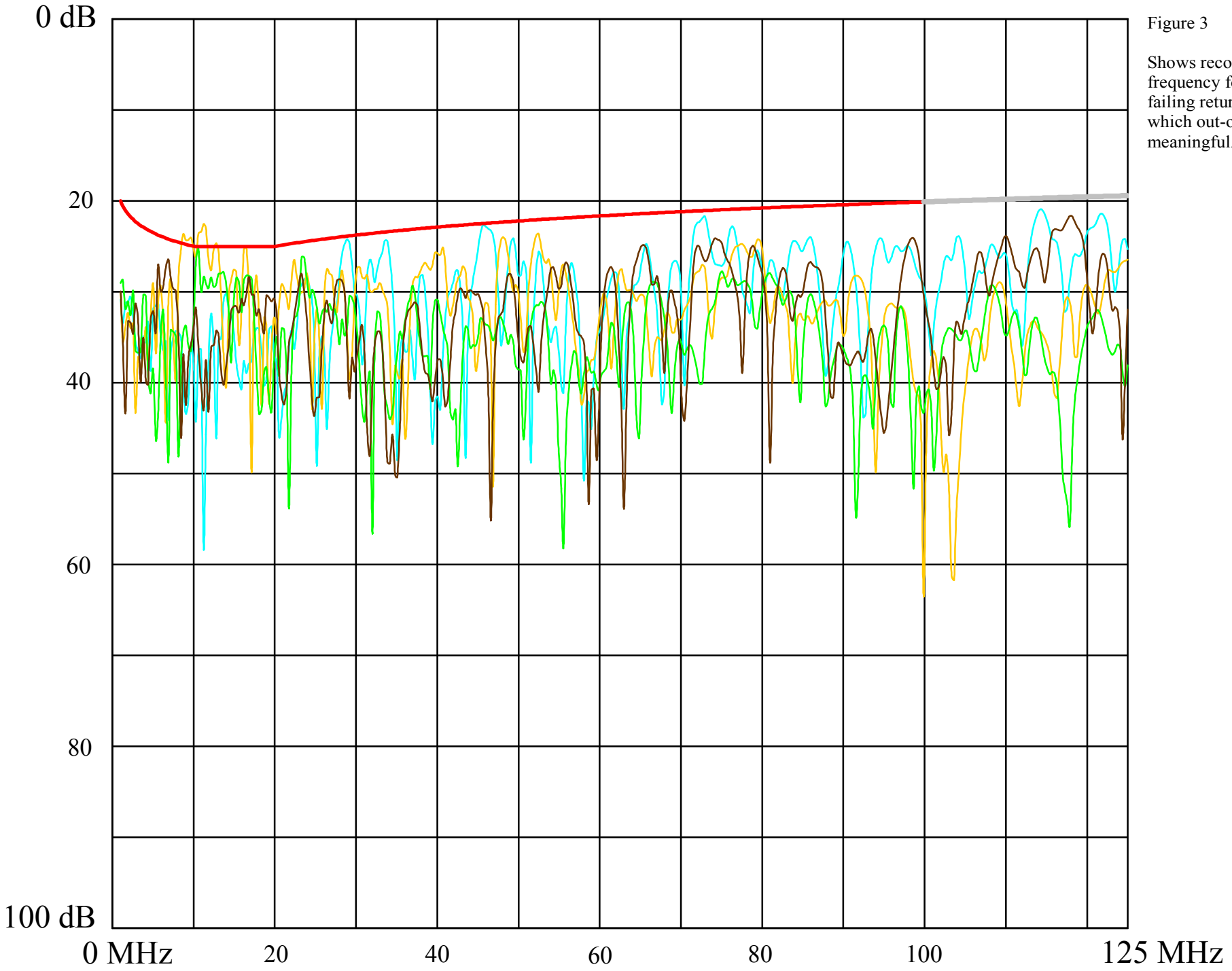

Figure 3

Shows recordings of return loss with frequency for a screened cable with failing return loss performance, for which out-of-box handling is not meaningful.