# Application of UWB Technique for Wall Shielding Measurements

F. Sonnemann, R.H. Stark
Diehl-BGT-Defence GmbH & Co.KG
90552 Roethenbach a d Pegnitz, Germany
frank.sonnemann@diehl-bgt-defence.de

***Abstract*— A measurement method to determine the electromagnetic properties of walls with ultra-wide-band (UWB) radiation technique is presented. The advantage of this method is the possibility to determine shielding effectiveness and dielectric constant of walls without the requirement of a closed shield environment.**

***Keywords-UWB; wall shielding; electromagnetic properties***

## I. INTRODUCTION

The standard method for measuring the effectiveness of electromagnetic shielding enclosures is based on a swept-frequency continuous wave (CW) technique in the frequency domain according to IEEE-STD-299. Because the method requires a closed shield environment, its application is only useful when the shielding of the building is complete.

The presented UWB measurement technique in the time domain has the advantage that due to different time delays the penetrated signal through a potential leakage can be separated from the scattered signal around the shield. Therefore, this technique is suitable to determine shielding properties of detached wall segments. The covered frequency range is given by the bandwidth of the radiated UWB pulse.

## II. STEEL REINFORCED WALLS

In the following example, the electromagnetic properties of a detached steel reinforced test wall shall be determined. An UWB transmitter and an UWB receiver unit are positioned on both sides of the 50 cm thick wall as shown in Figure 1.


Figure 1. Determination of the electromagnetic properties of a 50 cm thick steel reinforced wall segment with UWB technique

The distance between transmitter and receiver unit was chosen to $d_{TR}$ =1m. The propagation of the pulse through the wall is not only attenuated, but also reduced in velocity. This can be observed by measuring the time difference of the received probe signal at $d_{TR}$ =1m in free space $u_{ref}$ (t) compared to the received signal $u_{wall}$(t) with wall located between transmitter and receiver (Figure 2). The triggering was equal for both measurements. The time difference amounts to 3.8 ns and corresponds to the propagation time through the steel reinforced wall. The velocity v can be calculated to $v = d_{wall} / \Delta T = 1.32 \times 10^8$ m/s. From this, the relative dielectric constant $\varepsilon_r$ of the wall can be calculated to: $\varepsilon_r = (c_0/v)^2 = 5.1$, whereas $c_0$ is the propagation speed of light.

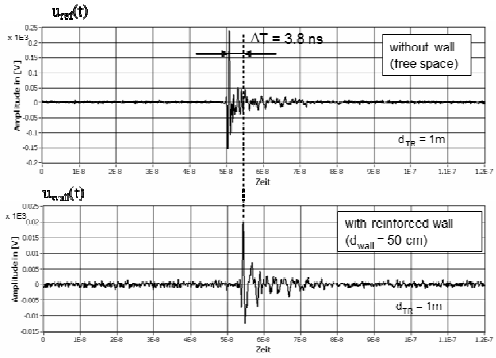


Figure 2. Received UWB probe signals $u_{ref}$(t) and $u_{wall}$(t)

Figure 3 shows the shielding effectiveness of the wall in the frequency range 0.4 – 1.9 GHz, calculated by SE = FFT{$u_{wall}$(t)} / FFT{$u_{ref}$(t)}. It can be noted that the attenuation increases with frequency which is assumed due to increasing absorption losses of water in the range of 2 GHz [1].

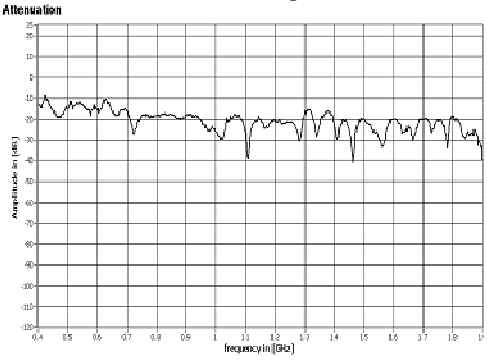


Figure 3. Shielding effectiveness of a 50 cm steel reinforced wall

## III. CONCLUSION

The presented time domain measurement method with time-gating technique is capable to determine the electromagnetic properties of walls and wall segments in their original environment.

## REFERENCES

[1] T. Frenzel, J. Rohde, J. Opfer, "Elektromagnetische Schirmung von Gebäuden", BSI-Richtlinie, BSI-TR-03209-2, April 2008